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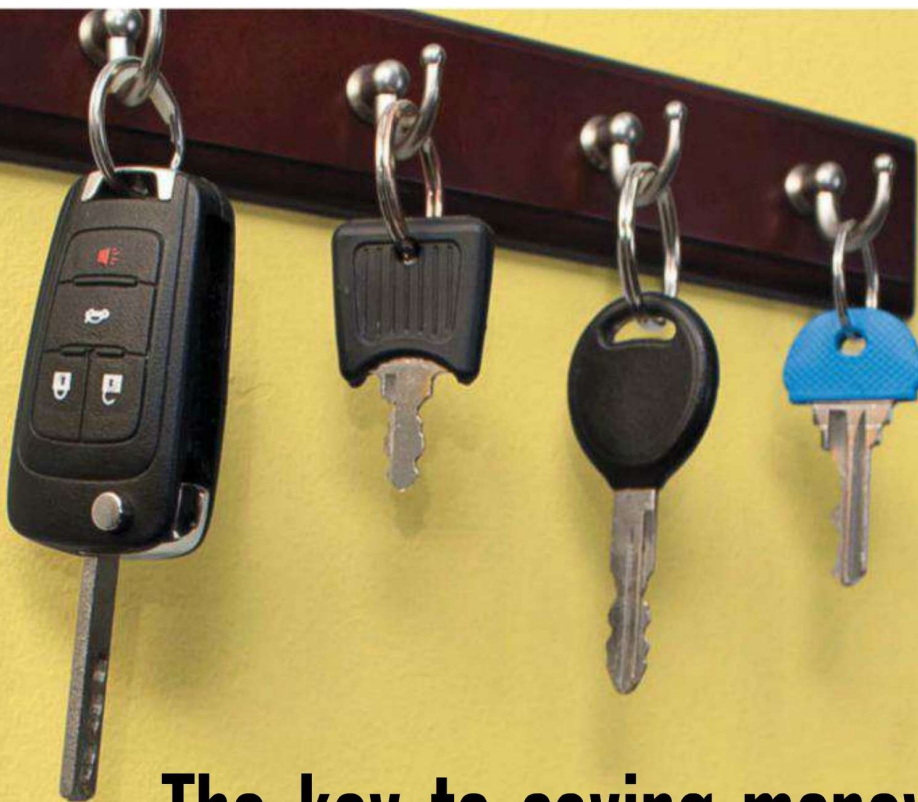


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Antique parts are on hand at Randy Ema's garage in Orange, Calif. Ema will fix any car, as long as it's a Duesenberg.

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PM FEATURES VOLUME 189 NO. 5

PopMech
May

78 Brotherhood of the Wrench Welcome to the obsessive underworld of esoteric auto repair, where mechanics dedicate themselves to maintaining the fringe vehicles of history.

BY EZRA DYER

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62 Reengineering the Human Prostheses have long served as crude replacements for lost limbs. But new bionic systems use robotics and advanced algorithms to mimic natural movement. BY ERIK SOFGE

72 Training Day Bombings, train wrecks, and earthquakes occur often in an old, abandoned West Virginia highway tunnel. All are simulations designed to prepare first responders for the worst. BY KALEE THOMPSON

On
the
cover

The Modular Prosthetic Limb, developed at Johns Hopkins University for DARPA, belongs to a new wave of bionic devices with superior dexterity and machine intelligence. A brain-controlled model is in clinical trials now. Photograph by Eric Ogden.

PHOTOGRAPH BY MATHIEU YOUNG

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41 Eight Is Enough The 2013 Bentley Continental GT replaces its massive W-12 with a slightly less massive twin-turbo V-8. **Plus:** Design students give their take on the future look of Lincoln.

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diy

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PHOTOGRAPH BY PHILIP FRIEDMAN

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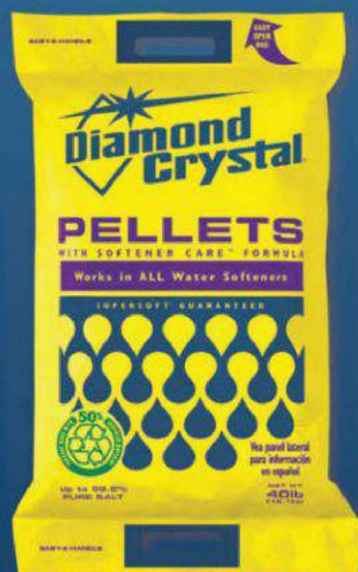


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SATURDAY MECHANIC ON YOUTUBE Starting May 1, tune in to the new Car and Driver channel on YouTube and follow PM editor Ben Wojdyla (below, right) as he leads viewers, step by step, through repairs and upgrades on the *Saturday Mechanic* show. Got car questions? Give him a call on Skype, and he'll answer them on the air. popularmechanics.com/satmechtv



SAVE THE STANDARD Every year automakers offer fewer cars with an old-fashioned clutch and shifter. Sure, automatic transmissions are more convenient for everyday driving, and the newest computer-controlled gearboxes in sports cars shift faster than any human ever could. But a manual is more engaging and fun, requires more skill, and makes you a better driver. These 10 driver's cars still come with a standard. popularmechanics.com/manuals

FAR-OUT PLANETARY SYSTEMS Our own solar system, with its handful of planets traipsing around an ordinary middle-age star, is a little dull. But the galaxy abounds with bizarre systems that feature planets traveling backward, planets orbiting two (or three or four) stars, and shadowy Trojan planets that use the same path as other worlds, stalking them as they orbit their suns. popularmechanics.com/solarsystems

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Army combat engineers Sgt. Mike Swart (left) and Cpl. Rob Curtis read PM in Kunar, Afghanistan. "My mom sends them in care packages, and the guys in the platoon love to read them," Swart says. Behind the men are Buffalo mine-resistant, ambush-protected (MRAP) vehicles.

Older, Wiser, and Archived

Happy 110th anniversary! Your junk-drawer photo ("Knowing Your Stuff," March cover story) hit the mark: It looks like you snuck into my house and took a picture of mine. *In purgamentum, nos sunt unum*—in our junk, we are one.

TOM SALES SOMERSET, NJ

Bravo on the March issue. Please bring back more of yesteryear in your upcoming editions. I love it.

STEVEN LEWIS PALM SPRINGS, CA

Great issue, guys. It would be amazing if you could put some old issues in digital format for us to read.

BRIAN MILLER BOTHELL, WA

EDITOR'S NOTE: We love our classic issues as well and will be featuring more vintage PM stories this year. You can view the PM archive online at books.google.com; search for "Popular Mechanics," plus whatever date or topic you'd like to find. Enjoy!

We love nothing more than an impassioned response. But for the record, our recommendations were adapted from ideas presented by experts across the political spectrum. Further, POPULAR MECHANICS has covered military technology, tactics, and related issues since the magazine was founded in 1902, and we have no plans to stop now.

CORRECTION: The Rogue Hoe 575g (Upgrade, March) is made by ProHoe of Munden, Kan.

From our fans
and followers



Hello, PM readers on Facebook and Twitter! Thank you for responding to our stories. Here are some recent comments:

Merry-go-round plane launchers: just another great/insane aviation innovation in the @PopMech archives.
@B_RESNICK, VIA TWITTER

"2012 Tornado Season Off to Explosive Start," popularmechanics.com: These tornadoes were farther east than usual—bad weather seems to be happening in places out of

the norm lately. Building codes should be as safe as possible. Nations and entire societies can be obliterated without proper preparation.

DERRICK AND DENISE HALVERSON, VIA FACEBOOK

"The Navy's Electric Cannon Fires Its First Shots," popularmechanics.com:

How about using the same method to place satellites into low-Earth orbit or send vehicles into deep space? Maybe this is the cannon gun that Jules Verne imagined.

RAFAEL DOMINGUEZ ESTRADA, VIA FACEBOOK

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do you
think?

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• MODERN WEAPONRY

Fire and Forget

A self-guided bullet developed by Sandia National Laboratories is the first small-caliber ordnance to change its flight to strike a target. The key: an optical sensor in its tip that zeroes in on a laser beam indicating its destination. With a standard charge, the bullet can travel twice the speed of sound and hit targets more than a mile away. Engineers attached a tiny LED to the bullet (shown in flight, above) to prove that the battery and electronics can survive the high-speed flight. — ALEX HUTCHINSON



• QUICK HITS



Attractive Solution

Scientists have developed a new tool that could make oil spills a little easier to clean up: magnetic soap. Chemists at the University of Bristol in England added iron atoms to a conventional surfactant made of chloride and bromide ions. Analysis using a high-energy neutron beam showed that the iron atoms clump together into clusters large enough to respond to a magnetic field, enabling the soap to be removed after it's deployed to break up a spill. In addition, an external magnetic field could control properties such as melting point, clumping size, and water solubility to make the soap fit the needs of different industrial applications.

QH

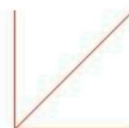
• QUICK HITS

**Prehistoric Snack**

■ Ancient remains discovered on the Peruvian coast show that our ancestors were eating popcorn 2000 years earlier than previously thought. Husks and stalks dating as far back as 6700 years indicate people cooked and ate corn in a variety of ways, including popping kernels over a fire. Corn was first domesticated about 9000 years ago in Mexico from a wild grass called teosinte and was often used to make flour. However, the archaeological evidence suggests that the ancient Peruvians ate popcorn like we do—as an occasional snack rather than a dietary staple.



The X-56A (shown here in an artist's rendition) is designed by Lockheed Martin's Skunk Works division.



• CUTTING-EDGE AVIATION

The Flutter Fighter

AN UNMANNED X-PLANE WILL TEST THE BOUNDARIES OF SHAPE-SHIFTING WINGS THAT COUNTER A POTENTIALLY DEADLY AERODYNAMIC FORCE.
BY STEVE ROUSSEAU

The Pentagon's newest experimental military aircraft isn't designed to evade radar or drop bombs; it's an unmanned science platform that could make high-altitude, long-endurance air travel safer. Air Force Research Laboratory (AFRL) engineers will use the X-56A to look at an aerodynamic phenomenon known as flutter—dangerous vibrations in an aircraft's wings. To counter flutter, engineers typically thicken structural reinforcements like spars and ribs. But this increases weight, which in turn eats up fuel. "We have a better approach," says AFRL project manager Pete Flick. Instead of stiffer wings the X-56A will test active flutter control, a system of sensors and flaps that detect and deflect increasing aerodynamic loads. Airplanes with active flutter control will be much lighter and so could potentially fly faster and more efficiently, Flick says.

UNDERSTANDING FLUTTER

Wing flutter is a phenomenon similar to what makes a flag flap. Vibrations caused by air passing over the wing can cause the wing to wobble or even snap in a matter of seconds. At a certain airspeed, at a certain altitude, the wings of any airplane may start to become unstable. These limitations are part of what test pilots use to define an aircraft's flight envelope—the conditions to which pilots must adhere to operate an airplane safely.

**FLIGHT-TEST STRATEGY**

Flutter is more severe at lower altitudes because the air is more dense. Therefore, X-56A researchers will conduct flight tests at higher altitudes to ensure the aircraft can adapt to the conditions before flying closer to the ground.



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3 HOW DATA IS RECOVERED

Time-delay balloons inflate so the sensor bobs to the surface. Researchers recover the device and download the information.

1 WHAT IT IS

Scientists developed the Sensor Fish to collect forensic data on what kills fish when they pass through dams and other aquatic infrastructure.

2 WHAT'S INSIDE

The device has accelerometers that detect impacts, a water-pressure gauge, and gyroscopes to measure the spin of fish caught in turbine wash.

• ENVIRONMENTAL SCIENCE

Dummy Fish, Smarter Dams

RECOVERABLE SENSORS SOLVE THE MYSTERY OF WHAT KILLS FISH TRAVELING THROUGH MAN-MADE RIVER OBSTACLES. *BY DAVID FERRIS*

Every spring in the Pacific Northwest, tens of millions of smolt (young salmon) swim through the Columbia River's hydroelectric dams on their way to the ocean, and every year as many as 10 percent emerge wounded or dead. The exact cause of the damage was a long-standing mystery.

So Tom Carlson, a senior scientist at Pacific Northwest National Laboratory, invented a device that could pass through the dams while recording data: the Sensor Fish.

After hundreds of tests, Carlson has the answer. As a salmon wriggles through the turbine blades, it suffers an abrupt drop in pressure. Its swim bladder suddenly expands or bursts, damaging other internal organs. The pressure change can also create air bubbles in the fish's blood,

causing a piscine version of divers' bends.

While Carlson covered the Sensor Fish in a polycarbonate plastic shell, Paul Heisey, a fisheries scientist with Normandeau Associates, attached the device's sensors to live fish for a more complete picture. "The condition of the recaptured fish, along with the hydraulic conditions obtained by the Sensor Fish, provide information on the type, severity, and cause of injuries," Heisey says. Using that data, he plans to propose modifications to power stations and spillways to make passage through them more benign for fish.

Carlson's team, meanwhile, is adapting the sensor—e.g., shrinking it to a 1-inch sphere—to create surrogates for many types of fish encountering various infrastructures.

The Alden Turbine contains design features inspired by Sensor Fish data. Its corkscrew shape minimizes the sudden pressure gradients fish experience. Because the turbine fits more snugly in its channel, its inventors say the efficiency of a full-scale turbine would be about 94 percent.

ILLUSTRATIONS BY JOE OLIVER (SENSOR FISH), DOGO (TURBINE)

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DISASTER'S AFTERMATH

Fukushima's Long Goodbye

Last March a tsunami damaged the cooling systems of three reactors at the Fukushima Daiichi nuclear plant, causing the leak of high levels of radiation. The Japanese government and plant owner Tokyo Electric Power Company recently released their cleanup plan: a 40-year process of isolating the facility, draining fouled water, and dismantling the buildings. *BY MARINA KOREN*



2012 Engineers install equipment that removes radioactive atoms migrating into underground water and seawater. The land must be repeatedly mapped for contamination because rain distributes the material unevenly in the soil. "It's not a uniform distribution," says Norman Kleiman, an environmental health sciences researcher at Columbia University's Mailman School of Public Health in New York. "We have potential hotspots of contamination here and there." Irradiated soil is removed and stored in secure silos.

2014 Workers begin to remove debris using remote-control robots. Contractor Takenaka Construction has already purchased demolition robots to tear down irradiated buildings. The company extended the 4300-pound robots' range, added a video camera, and hardened them against contamination. "High fields of gamma radiation can cause plastics and electronic chips to degrade," says Lake Barrett, who supervised the cleanup at Three Mile Island for the U.S. Nuclear Regulatory Commission.

2015 Workers use newly invented chemical sealants to plug holes in areas of the plant flooded with radioactive water. They drain the water from the reactor building and employ custom-made underwater robots to collect debris from inside the spent-fuel pools.

2016 A cover for the reactor building is installed to enclose the space. Additional video cameras monitor teleoperated work inside the reactor and turbine buildings, which are drained and repaired.

2022 Removal of the fuel rods from the damaged reactors begins. The rods have melted and fallen apart, complicating the cleanup.

2030 and beyond The last of the fuel is removed from the reactor buildings. Demolition crews then dismantle the entire facility, a process that takes decades.



'69 Chevy Camaro Z28
Owner: Leslie Gentry, Actual Carcissist



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• EMERGENCY RESPONSE

Bark-Activated Bots

A

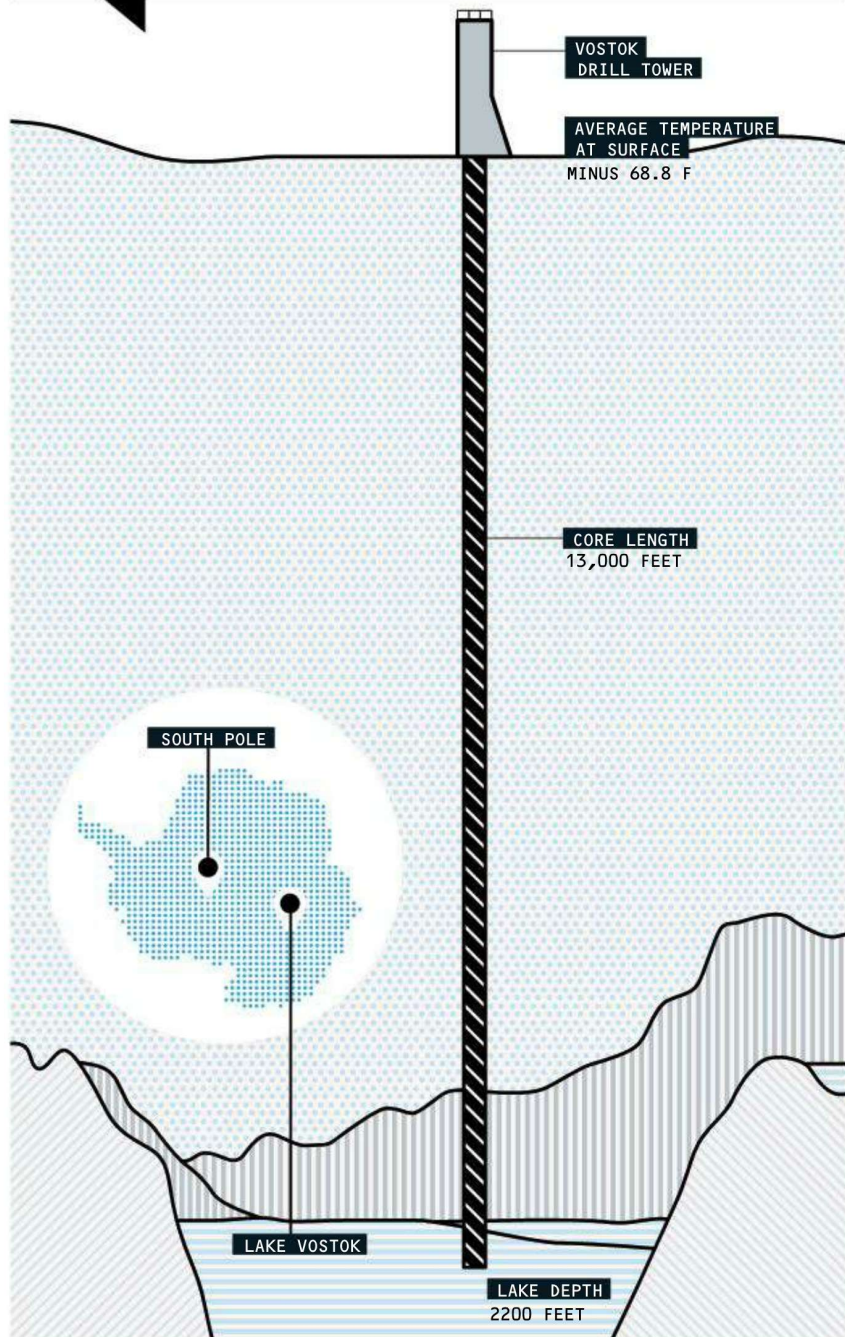
A highly trained dog's dexterity and keen sense of smell make it an excellent resource for rescuing people from areas strewn with debris; on the other hand, a sensor-studded robot can squeeze into tight spots and withstand toxic environments. Researchers at Ryerson University in Toronto have developed a system that takes advantage of both: a rescue robot that rides in a pouch attached to a dog. The pooch gets as close as possible to a trapped victim, then barks to deploy the robot. During recent tests at Texas A&M University, researchers demonstrated the Canine Assisted Robot Deployment system using a German shepherd named Freitag and a snakelike rescue robot developed at Carnegie Mellon (below).

—ALEX HUTCHINSON

Snakelike robots can be fit with infrared cameras and other sensors to find trapped people at disaster sites.



• EXPLORING EARTH



Polar Plunge

After a decade of continuous drilling through miles of ice, scientists with Russia's Arctic and Antarctic Research Institute have finally reached Lake Vostok. One of Antarctica's roughly 280 subglacial lakes, Vostok has not been exposed to the atmosphere in 15 million to 34 million years. The scientists will return to the site next year to retrieve the frozen core of lake water that now plugs their borehole. If the water contains organisms, it means life might also exist on the icy moons of Jupiter and Saturn.



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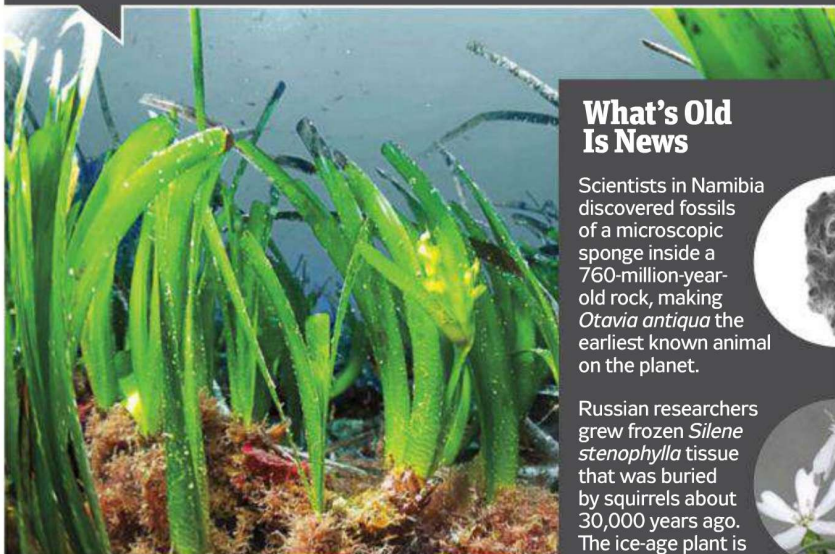
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TECH WATCH

NATURAL WONDERS



What's Old Is News

Scientists in Namibia discovered fossils of a microscopic sponge inside a 760-million-year-old rock, making *Otavia antiqua* the earliest known animal on the planet.

Russian researchers grew frozen *Silene stenophylla* tissue that was buried by squirrels about 30,000 years ago. The ice-age plant is the oldest ever to be regenerated.

A woman was recently arrested for burning down the Senator, a 3500-year-old cypress tree in Longwood, Fla. The bright side: Scientists transplanted seven cloned shoots that are now growing.



Methuselah of Plants

Scientists are discovering just how much longer cloned organisms can live, compared with those that breed sexually. The original genotype of *Posidonia oceanica*, a sea grass native to the Mediterranean, has been found to be tens of thousands of years old—possibly up to **200,000**. Not surprisingly, it's also one of the slowest-growing plants in existence. — JOE PAPPALARDO

EVERYDAY CHEMISTRY

Champagne Science



Should you drink champagne from a tall, narrow flute or a shallow, wide glass? To investigate, French scientists (who else?) used microgas chromatography and infrared imaging to measure the levels of carbon dioxide that bubble above the glasses after pouring. The tests confirmed what expert tasters have long reported: More CO₂ accumulates above the narrow opening of the flute, creating a sharper champagne smell.

— ALEX HUTCHINSON

DID YOU KNOW?

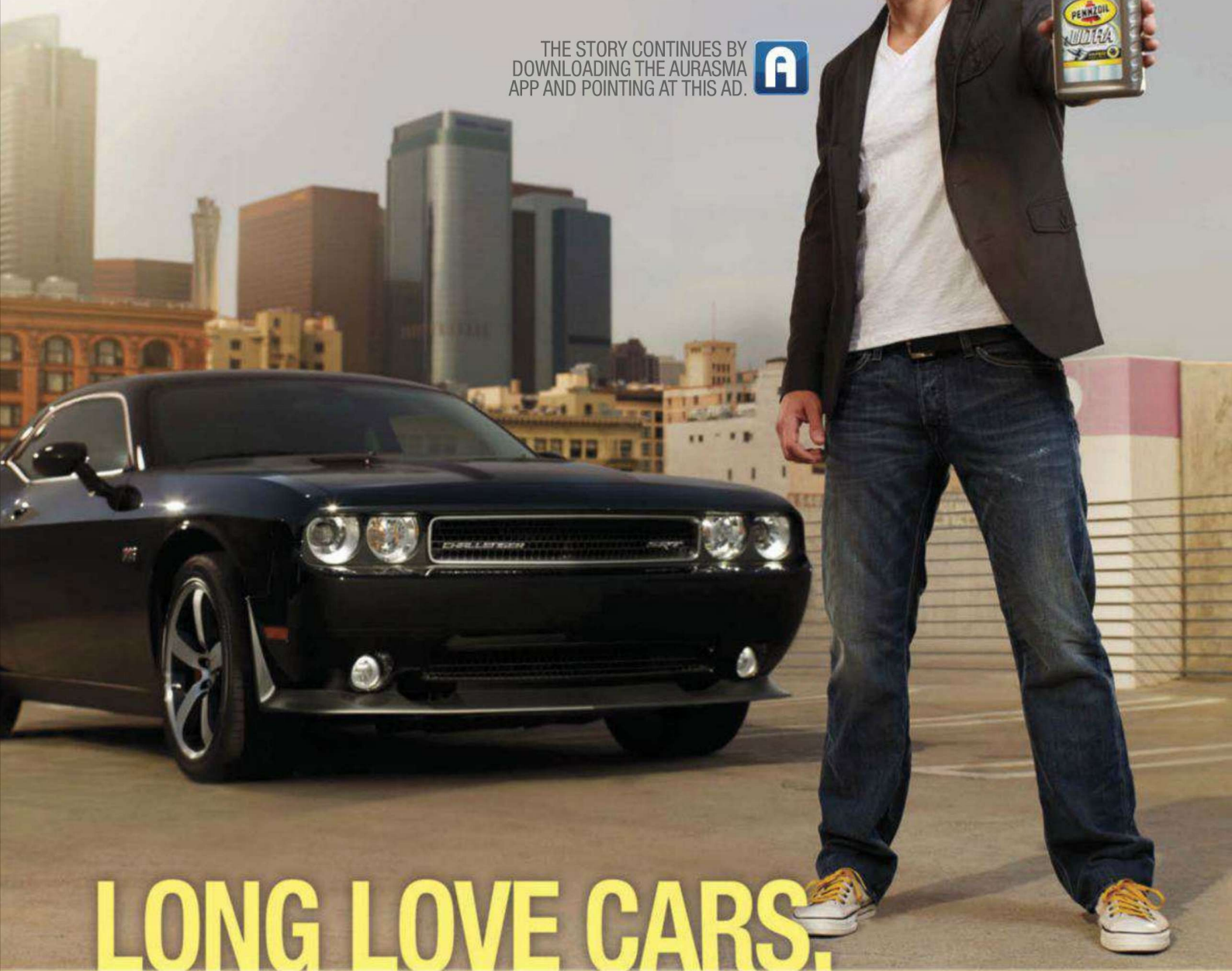
A standard bottle of champagne contains the equivalent of 1.3 gallons of dissolved CO₂ gas.



*"I HAVE MY MOTHER'S NOSE
AND MY DAD'S RIGHT FOOT,"*

-JASON THOMAS

THE STORY CONTINUES BY
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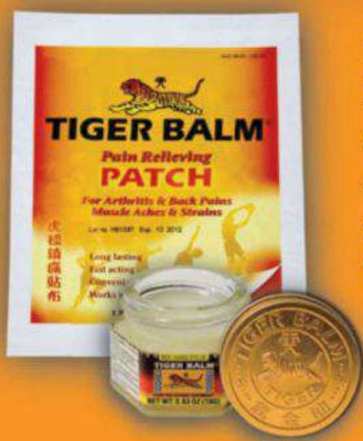
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Upgrade

The Next Big Hit

The ping of a baseball popping off an aluminum bat can herald a superhuman swat, but those high-velocity line drives can cause devastating injury to a collegiate or Little League player. New 2012 regulations known as BBCOR—inside baseball, that’s “batted ball coefficient of restitution”—force bat manufacturers to find a way to make aluminum and composite bats perform more like wooden ones. To play by the new rules, some manufacturers have wedged discs inside the barrels, and others have slimmed down key spots of the bat’s walls by hundredths of an inch. So do the sticks work? We took batting practice with two styles of the new bats, an Easton and a Louisville Slugger, along with a white ash classic. The bats hit with a wooden thump and a lower velocity than the aluminum of yore. But one stood out as the smoothest swinger with the biggest sweet spot. Turn the page to see the bat we’d take to the on-deck circle.

— HARRY SAWYERS

Composite inserts dampen this aluminum bat’s trampoline effect on a sharply hit ball.

HISTORY OF METAL BATS

1924

William Shroyer gets US Patent 1,499,128 for the first metal baseball bat.

1972

St. Louis group Worth Sports debuts the first official Little League aluminum bat.

1974

Worth introduces the first metal bat for NCAA use, the Tennessee Thumper.

1993

Titanium bats appear for use in softball and are banned the same summer.

1996

DeMarini debuts the double-walled aluminum bat. Two thin walls improve performance over a standard single-walled bat.

2001

Louisville Slugger breaks out the Genesis, the first composite bat, made of fiberglass, graphite, Kevlar, and resin.

2006

Easton builds a Stealth CNT composite bat, composed of a carbon nanotube-reinforced resin that slashes bat weight.

At the Plate

New technology is changing the game of baseball in the batter's box and the bleachers.



PM
PICK

HOT BATS

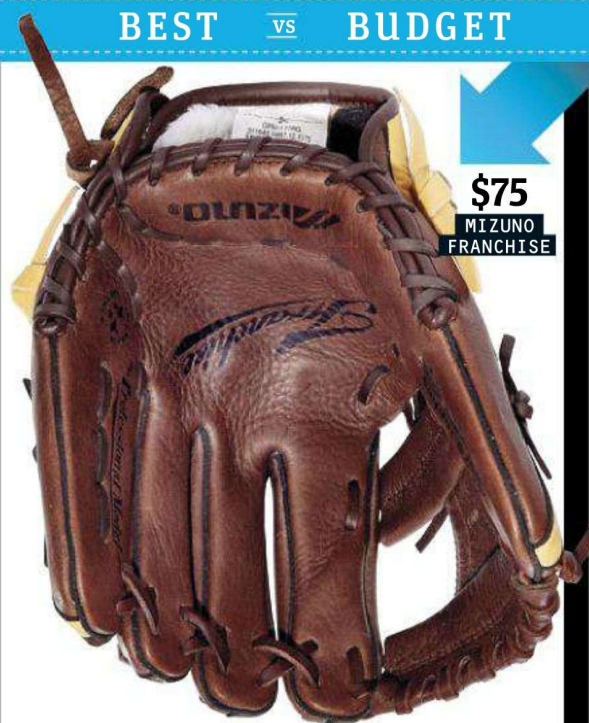
1. The exterior walls of the *Easton Power Brigade S3* (\$200) vary in thickness by thousandths of an inch, from the end of the taper to the barrel's fat sweet spot. Three testers agreed that this 33-inch model had the swiftest swing and the smoothest stroke. Vibration was as rare as the Cubs making the playoffs.
2. The hybrid *Louisville Slugger Exogrid 2* (\$300) has an aluminum handle and composite inserts. In a test at a New York City batting cage, the Exogrid proved equal in power to a white ash bat, but it felt just a bit heavy and clunky for such a slender 34-inch bat.

UPGRADE



\$300
NOKONA
BLOODLINE

BEST vs BUDGET



\$75
MIZUNO
FRANCHISE

Fielder's Choice

Stiff leather distinguishes the *Nokona Bloodline*, a tougher fielder's glove to break in than the game-ready *Mizuno Franchise*. But the longer a glove takes to break in, the longer it lasts, Nokona's Chris Miller says. He hears many wrong ways to do the job—some folks microwave the glove, run it over with a car, slather it with butter, or expose it to extreme heat or moisture. To do it right, he says, you can wrap it in a belt with a ball nestled in the pocket. Or you can just play a lot of catch.



LOCAL BEACON

↑ The simple, satisfying *Sony ICF-S10MK2 Radio* (\$20) uses exactly two knobs to tune in and turn up area broadcasts. Fold the antenna, slip the radio into your pocket, take it to the porch—and make it to the post-season without ever having to replace the pair of AA batteries.



UPPER-DECK SPECS

↑ Buy tickets for the cheap seats and use the savings to splurge on the new *Bushnell H20 10x42 Binoculars* (\$170). The waterproof, fog-proof glasses can weather a rain delay, show a play at the plate, and locate cardinals, blue jays, and orioles in the off-season.

Prescription only



Ready to try to quit smoking? Meet another option.

Nicotrol[®] Inhaler
(nicotine inhalation system) 

Trying to quit smoking but need some help? Talk to your doctor to see if NICOTROL Inhaler—the inhaled prescription nicotine replacement therapy—may be right for you.

NICOTROL Inhaler, when used as part of a comprehensive behavioral smoking cessation program, may help you quit smoking by reducing your urge to smoke.¹

For more information on NICOTROL Inhaler, visit www.Nicotrol.com/2012

Indication

NICOTROL Inhaler is indicated as an aid to smoking cessation for the relief of nicotine withdrawal symptoms. It is available only by prescription and is recommended for use as part of a comprehensive behavioral smoking cessation program.

Important Safety Information

Do not use the NICOTROL Inhaler if you are hypersensitive or allergic to nicotine, menthol, or to any ingredient in the product.

If you have cardiovascular, peripheral vascular, or bronchospastic diseases including asthma or chronic pulmonary disease, talk to your doctor about using the NICOTROL Inhaler. If you are under a doctor's care for any condition, you should first discuss with your doctor the potential risks of using this product.

You should stop smoking completely before using the NICOTROL Inhaler. You should not smoke or use other nicotine-containing products while under treatment with the NICOTROL Inhaler.

Because nicotine is addictive, it is possible to become dependent on the NICOTROL Inhaler. It is important to use it only for as long as needed to overcome your smoking habit. The safety of treatment with the NICOTROL Inhaler for periods longer than 6 months has not been established, and such use is not recommended.

Please see Brief Summary of Important Risk Information for NICOTROL Inhaler on the back.

A special note about children and pets: The NICOTROL Inhaler can cause serious illness or be fatal in children and pets—even in very small amounts. If a child chews on or swallows new or used NICOTROL Inhaler cartridges, immediately call a doctor or call your regional poison center.

The specific effects of the NICOTROL Inhaler treatment on fetal development and nursing infants are unknown. Therefore, pregnant and nursing smokers should be encouraged to attempt cessation using educational and behavioral interventions before using pharmacological approaches.

You are likely to experience mild irritation of the mouth or throat, or cough when you first use the NICOTROL Inhaler. In clinical trials, the frequency of mouth or throat irritation, or coughing declined with continued use. The most common nicotine-related side effect was upset stomach. Other nicotine-related side effects were nausea, diarrhea, and hiccup. Smoking-related side effects included chest discomfort, bronchitis, and high blood pressure.

It is important to tell your doctor about any other medications you may be taking because they may need dosage adjustment.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch, or call 1-800-FDA-1088.

1. Nicotrol Inhaler [prescribing information]. New York, NY: Pfizer Inc; 2008.



10 mg per cartridge (4 mg delivered)

Important Facts About NICOTROL Inhaler

This information does not take the place of talking to your doctor about your medical condition or your treatment.

What is the most important information I should know about NICOTROL Inhaler?

Do not use NICOTROL Inhaler if you are hypersensitive or allergic to nicotine or to menthol.

Because you are already addicted to the nicotine in cigarettes, it is possible to stay dependent on the lower dose of nicotine found in the NICOTROL Inhaler. It is important to use the Inhaler for only as long as directed by your doctor to overcome your nicotine addiction and smoking habit.

People who use NICOTROL Inhaler with a comprehensive behavioral smoking cessation program are more successful in quitting smoking. This program can include support groups, counseling or specific behavior change techniques.

Remember:

- **Do not use more than 16 cartridges each day unless directed to do so by your doctor**
- **Do not use NICOTROL Inhaler longer than 6 months**

Keep out of reach of children and pets. The NICOTROL Inhaler can cause serious illness in children and pets—even in very small amounts. If a child chews on or swallows NICOTROL Inhaler cartridges, call a doctor or Poison Control Center.

NICOTROL Inhaler may cause side effects. Many people experience mild irritation of the mouth or throat and cough when they first use the NICOTROL Inhaler. Most people get used to these effects in a short time. Stomach upset may also occur. Nicotine from any source can be toxic and addictive.

If you are pregnant or breast-feeding, only use this medicine on the advice of your health care provider. Smoking can seriously harm your child. Try to stop smoking without using any nicotine replacement medicine. This medicine is believed to be safer than smoking. However, the risks to your child from this medicine are not fully known.

What should I know before I start using NICOTROL Inhaler?

Commit yourself – NO SMOKING! For the NICOTROL Inhaler to help, you must be firmly committed to quitting! **Stop smoking** as soon as you **start using the Inhaler**. Do not smoke or use any other tobacco products at any time while using the NICOTROL Inhaler.

Nicotine overdose can occur. If symptoms of overdose occur, call a doctor or Poison Control Center immediately. Overdose symptoms include: bad headaches, dizziness, upset stomach, drooling, vomiting, diarrhea, cold sweat, blurred vision, hearing difficulties, mental confusion, weakness and fainting.

What is NICOTROL Inhaler?

NICOTROL Inhaler helps you quit smoking by reducing your urge to smoke. Success in quitting with nicotine replacement therapy (such as NICOTROL Inhaler) usually involves behavior change. Your doctor may adjust the number

of Inhaler cartridges during the first few weeks. As your body adjusts to not smoking, your doctor will either tell you to stop using the Inhaler or slowly reduce the dose.

What is a nicotine replacement therapy?

Nicotine replacement products are one type of smoking cessation product. Designed to wean your body off cigarettes, they supply you with nicotine in controlled amounts while sparing you from other chemicals found in tobacco products.

What should I tell my healthcare provider before using NICOTROL Inhaler?

Tell your doctor if you have:

- heart problems (recent heart attack, irregular heartbeat, severe or worsening heart pain)
- allergies to drugs
- high blood pressure
- diabetes requiring insulin
- stomach ulcers
- kidney or liver disease
- overactive thyroid
- wheezing or asthma

Tell your doctor about any medicines you are taking—the dosages may need to be changed. Check with your doctor before taking any new medicine while using NICOTROL Inhaler.

What are the possible side effects of NICOTROL Inhaler?

You may experience mild irritation of the mouth or throat and cough when you first use the NICOTROL Inhaler. You should get used to these effects in a short time. Stomach upset may also occur.

Tell your doctor if you have any side effect that bothers you or that does not go away. Call your doctor for medical advice about side effects.

How do I use NICOTROL Inhaler?

Follow doctor's directions. Stop smoking completely during the NICOTROL Inhaler treatment program. See full Patient Information for additional details.

How should I store NICOTROL Inhaler?

- Store cartridges at room temperature, not to exceed 77° F (25° C)
- If you keep cartridges in car, be careful: interiors heat up quickly
- Protect from light
- Clean mouthpiece regularly with soap and water

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch, or call 1-800-FDA-1088.

Need more information? Ask your doctor or healthcare provider. Talk to your pharmacist. Visit to www.NICOTROL.com or call 1-800-222-7200.

References: 1. Nicotrol Inhaler [prescribing information]. New York, NY: Pfizer Inc; 2008. 2. FDA 101: Smoking cessation products. U.S. Food and Drug Administration Web site. <http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm198176.htm>. Accessed November 14, 2011.

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Welcome to the Wonderful World of Concrete!

In case you missed it this past winter, a massive collection of craftsmen and manufacturers occupied more than 500,000 square feet of Las Vegas with tool demos, construction challenges, clinics, and celebrations of everyone's favorite cementitious aggregate. Here's a peek at the World of Concrete: the biggest trade show you never knew existed. *BY CONOR SHINE*

DREAM CLEAVER

↓ The power to precisely slice a slab of concrete, metal, brick, or stone is priceless, even if the machine to do it doesn't come cheap. The **Stihl TS 500i Cutquik** (\$1000), a coveted cut-off wheel, runs on a fuel-injected two-stroke engine. The engine does not waste unburned fuel in a carburetor, and it adjusts in response to weather and fuel quality to maximize efficiency.



ROCK IN A ROLL

↑ With a thin, layered sheet of concrete mix, reinforcing fibers, and a PVC backing, **Concrete Cloth** (\$4 to \$9 per square foot) simplifies concrete application to one step: Just add water. Rolled out like a carpet, the cloth takes the shape of the underlying surface, whether it's a drainage ditch or a boat ramp. The main advantage is the speed of installation—there is no form to build and no mix to stir. It rolls out, begins to cure 2 hours after it's wet, and sets in just over 24 hours.



STRUCTURAL CELLULOSE

↑ Made of recycled paper and cement, **Greenstar Brix** (\$0.35 each, sold by the thousand) are alternative veneer bricks that weigh less and insulate better than masonry made of traditional materials. Resistant to fire, water, and mold, the 3 $\frac{5}{8}$ x 2 $\frac{5}{8}$ x 7 $\frac{5}{8}$ -inch units have gotten laid all over Texas Hill Country.

CUTTHROAT CONCRETE CONTESTS

TWO TRADE SHOW EVENTS TEST THE SPEED AND SKILL OF MASONRY MASTERS.

Spec Mix Bricklayer 500

The Spec Mix Bricklayer 500 pits 21 teams in an hour-long race to build the best 26-foot 8-inch double-wythe brick wall. At the sound of the buzzer, gentlemen start their wheelbarrows, then get busy spreading mortar and setting bricks. Thirty-one-year-old Missouri mason Leif Reints won the first-place prizes—a new Ford F-250 truck, \$5000, and a Stihl cut-off machine (like the one at left)—by laying 583 bricks in 60 minutes.

Trowel Challenge

At the annual Trowel Challenge, the fastest guy to finish smoothing a 2400-square-foot concrete slab wins a Wacker Neuson CRT 48-35VX ride-on trowel (and a trip for two to the Caribbean). This particular machine is customized—as the manufacturer says, “We have it chromed up”—but the closest on-the-market equivalent retails for \$19,520. This year, Darin Wiebe of Linden, Alberta, won it all by finishing the slab in 33.116 seconds.

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CAN YOU HANDLE THIS LAWNMOWER? Cub Cadet product manager Adam Ference describes the GTX 1054's owner with genuine admiration. "These folks are true yard enthusiasts," Ference says. "They're engaged with property on a deeper level than just going out and cutting grass." He says some married couples—once given a taste of the "mow therapy" offered by the 54-inch triple-blade mowing deck, the electronic power steering, the hydrostatic transmission, and the forklift-inspired Cub Comfort seat—actually compete for dibs on who gets to mow the lawn. "They race home to get on it first," he says. Sound like you? Enter to win!



POPULAR MECHANICS CUB CADET GIVEAWAY Random-draw sweepstakes: no purchase necessary to enter or win. Popular Mechanics Cub Cadet GTX 1054 Sweepstakes. Sponsored by Hearst Communications, Inc. Beginning April 15, 2012, at 12:01 AM (ET) through May 22, 2012, at 11:59 PM (ET), go to popularmechanics.com/cubcadetsweeps and complete and submit the entry form pursuant to the online instructions. Odds of winning will depend upon the total number of eligible entries received. Must be a legal resident of the 50 United States, District of Columbia, or Canada who has reached the age of majority in his or her state, territory, or province of residence at time of entry. Void in Puerto Rico, in the Province of Quebec, and where prohibited by law. Sweepstakes subject to complete official rules available at popularmechanics.com/home/improvement/lawn-garden/cub-cadet-gtx-1054-rules.

FIVE GREAT LAWNS

The Lawn Club on Celebrity Solstice

To prevent the weight from sinking the boat, the Bermuda/ryegrass turf on Celebrity Solstice cruise ships is grown in a lightweight calcium clay and volcanic pumice medium. Onboard lawns may be subject to salt air, scavenging gulls, and the occasional gale but not to stilettos—no high heels are permitted.

Grand Hotel Mackinac Island, Mich.

The strict limit on motorized vehicles on Mackinac Island does not include the riding mowers that stripe the 125-year-old lawn known as the Tea Garden. Victorian guests played ballgames and danced on the lawn, which is still used for genteel pastimes such as croquet and bocci.

Millennium Park, Chicago

Facing the Frank Gehry–designed outdoor concert pavilion, the Great Lawn at Millennium Park can seat 7000 people. Part of one of the largest green roofs in the world, the sod is planted on a vast expanse that covers an underground parking garage and is supported by massive caissons.

The Lawn at the University of Virginia

Designed by Thomas Jefferson, the 4-acre Lawn (yes, it's capitalized) at the Charlottesville campus was named one of America's Top 10 lawns by Briggs & Stratton. Here students perform the traditional lawn streak, stripping inside the Rotunda and racing across the green to touch the feet of Homer's statue.

Central Park Sheep Meadow

By the time the Central Park Conservancy took over the historic Sheep Meadow in New York's Central Park in 1980, years of neglect had turned it into a dust bowl. Now the 15-acre Kentucky bluegrass lawn provides a verdant carpet for up to 30,000 Frisbee-throwing people a day.

THREE SWEET GRASSES

CALIFORNIA

Sedge ground covers, such as European meadow sedge (*Carex remota*), produce a prairie-style lawn that thrives in dry, sunny conditions.



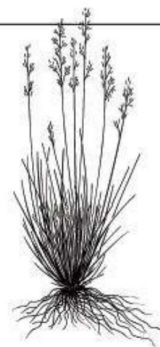
FLORIDA

Seashore paspalum thrives in salty soil and water. But it's tough to keep up. Irrigation, pest control, fungicide, and reel mowing are a must.



ANYWHERE

No-Mow lawn mix is a fescue blend that grows dense in sun or partial shade. It requires little water or fertilizer, and interlocking roots stifle weeds.



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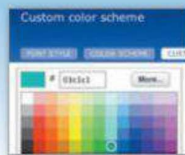
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DIRECTIONS

- Brush on a THIN, EVEN COAT in the direction of the grain. Be sure to maintain a wet edge.
- Let dry 6 hours or more, then rub surface with fine steel wool (grade 000 or finer). Remove all dust.
- Brush on a second THIN coat.
- For added durability apply a coat of Minwax® Fast-Drying Polyurethane.

For detailed directions visit minwax.com



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1 PIPSQUEAK POINTER

Trackpads and touchscreens could kill the computer mouse. But wild new designs such as the **Logitech Cube Mouse (\$70)** are fighting for the species' survival. To scroll, stroke the wireless tool's Bic-size back. To click through slides, pick it up and pinch. It's small enough to fit in a shirt pocket, but that's also its biggest problem: It's just painful for a human hand to use.

2 BRING ON THE NOISE

Noise-canceling headphones tend to put a high price on silence. The solid, affordable **Creative HN-900 (\$100)** fills a big need—if you could afford a \$400 pair from Bose or Sony, wouldn't you be riding in a limo instead of this loud old bus? The Creative's audio and noise-canceling performance are both decent, and the latter can be deactivated to save battery life.



3 THE FUTURE OF TV (DELUXE)

The hardware tied to Google TV's second act, the **Sony NSZ-GS7 Network Media Player (\$TBA)** offers an easy search for shows and a remote with a keyboard and a trackpad. It could kill the cable box. But it debuts this summer to a market with 100 million U.S. homes with cable, only a million Google TV devices in use, and an industry resistant to selling content à la carte.



4 THE FUTURE OF TV (CHEAP)

Cord-cutters with no DVR still need to record and pause live TV. That premise is behind the **Simple.TV (\$149)**, a set-top box for the anti-cable crowd. Paired with a Web connection and an HD antenna, the tuner streams digital video to a mobile device. But it also must be paired with external data storage, it only records one show at a time, and it lacks Wi-Fi connectivity.

5 THIS PHONE IS ROAMING

With a smartphone docked as a processor, and a second phone acting as a controller, the **Romo (\$99)** seems like a novelty bot. It can race! It can fight! The significance of the open-source project (besides raising over \$1.5 million on Kickstarter): Anyone conversant in iOS or Android can code unique new behaviors. Write apps, learn the basics of robotics, and, yes, win a fight.

6 BEEFCAKE GAMING TABLET

There is a video-game gap on tablets: For a hardcore PC gamer, Angry Birds won't do. The proof-of-concept **Razer Project Fiona (\$TBA)** fits a full-fledged PC in the body of a tablet. A pair of controllers bookend a multitouch screen with a powerful Intel Core i7 inside. The guts and the interface take a tablet to the console level—Skyrim, anyone?—at a late-2012 launch. —H.S.





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1 POCKET TOOLBOX

Veteran knife-maker Ed Van Hoy and partner Tom Stokes designed the **CRKT Multi-Tool 9200 (\$50)** to fill in for a loaded toolbox. For an electrician, there's a utility blade to cut drywall, a (kinda thick-bladed) saw for studs, two screwdrivers to mount a box, and a wire stripper. "I like to build stuff that a guy could go out there and use," Van Hoy says. We especially like the swift, automatic spring-loaded screwdrivers.

2 METALWORKING MEDLEY

The **Multiplaz 3500 (\$1995)** does it all at a metal shop. Applied to steel, aluminum, copper, iron, and bronze, the unit uses water and alcohol to weld, solder, braze, harden, cleanse, or cut. The tool replaces a welder, a gas torch, a plasma cutter, nibble shears, a jigsaw, a blow lamp, and an inverter welder. But that's it!

3 NEW TWIST ON A GREAT GRINDER

In the age of plastic pepper mills, a grinder like the **Peugeot Daman u'Select (\$60)** is worth an investment. In this new model, which does away with the central shaft, two sets of case-hardened steel teeth guide and hold each peppercorn before it's cracked. The two-stage grinding process releases the pepper's oils while also protecting the tool against corrosion and wear.

4 FADE IT, SHAPE IT, SHAVE IT

Gillette videotapes more than 48,000 guys shaving at its labs every year, using cameras that record the cutting action of five blades at once. The research has paid off with the **Gillette Fusion ProGlide Styler (\$20)**. The handle accommodates the razor or a AA-powered Braun trimmer head. The pair can be swapped to perfect a sideburn edge or banish a five o'clock shadow. — H.S.



3 Months With the Nest Thermostat

BACKGROUND: The brainchild of ex-Apple engineers, the Nest aims to bring HVAC into the 21st century. The setup was intuitive, but a pesky wiring fault took 3 hours to correct.

PERFORMANCE: Users adjust the temperature with a dial surrounding a color display. In a week the device learns your schedule. It has proximity sensors to detect your presence. A Wi-Fi connection means it can be controlled via the Web or smartphones.

CONCLUSION: Nest's user interface is clean and simple, and it affords you a mind-boggling amount of control. But at \$250, a Nest is much pricier than a standard thermostat. The promise of the Nest is an efficient system that you don't need to think about, but in my experience the exact opposite proved true. As the Nest anticipated my needs, I constantly second-guessed it, wondering, would I really have wanted the furnace to kick on right now? — GLENN DERENE

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² – Based on commissioned third-party wear test results versus Continental® ProContact™ with EcoPlus Technology tire size 215/60R16.

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HARLEY 72 + BRZ VS MIATA +
DESIGN CLASS + NEW PRIUS

New Cars

2013 BENTLEY CONTINENTAL GT V-8

→ base price \$175,000 (est.)

ENGINE

twin-turbo 4.0-liter
V-8; 500 hp, 487 lb-ft

TRANSMISSION

eight-speed automatic

0-TO-60

4.6 seconds

TOP SPEED

188 mph

EIGHT IS ENOUGH

Apparently even the wealthy are starting to worry about fuel efficiency. Now Bentley, a company that has built a reputation on powerhouse megaweight machines, is shedding cylinders to boost efficiency. Bentley's current 12-cylinder Continental has locomotive-like thrust. Trouble is, it gulps fuel like a locomotive too, with numbers (12 city, 19 hwy) that would make an F-150 4x4 blush. So this fall we'll see a new 500-hp Continental GT V-8 that delivers around 17 mpg city and 26 mpg highway. The new twin-turbo V-8

is shared with Audi and is paired with an eight-speed automatic that provides a 6 percent efficiency gain on its own. At 5000 pounds, the all-wheel-drive Continental is certainly no sports car. But as we found on the Circuito de Navarra racetrack in Spain, 500 hp can make even porky cars feel quick. Plus, the raspy exhaust note reminds us of a slightly less rabid Corvette Z06. The V-8 is also 55 pounds lighter than the 12, so there's less weight on the front axle. As we circled the track, we could actually feel that the new Bentley is just a bit

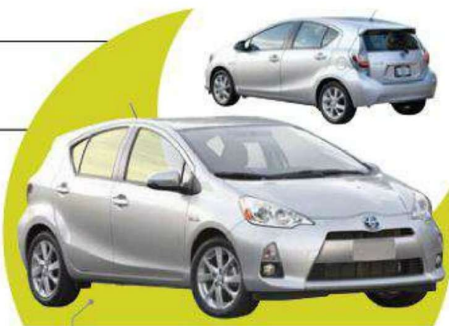
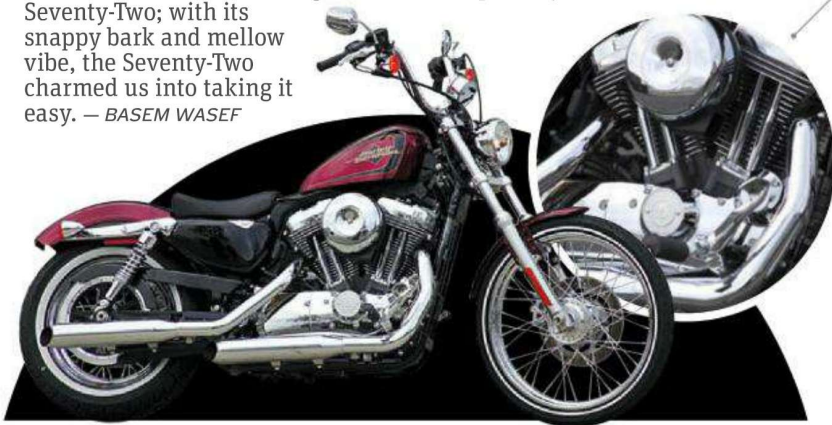
crisper in the turns but still ferociously fast. We touched 130 mph on the straights. Thankfully, the GTs we sampled carried Bentley's optional, astonishingly large, and awesomely powerful 16-inch ceramic brakes (another 10 grand or so, but once you clear \$150K, who's counting?). On public roads, passing is so effortless we wonder who would opt for the 12-cylinder model, which is still available. But when you're talking about six-figure coupes—even ones as slick as the Bentley—rational thought often takes a pass. — BEN STEWART



New Cars TEST DRIVES

ALL CHOPPED UP

Despite its discreetly hidden fuel injectors, Harley-Davidson's Seventy-Two is still a defiantly anachronistic motorcycle. Using the decades-old Sportster platform with a 1.2-liter V-twin, the Seventy-Two evokes ornate styling elements from '60s-era choppers: a front fork raked to 30.1 degrees, towering 10-inch mini-ape handlebars mounted on a 2-inch riser, and chopped fenders. Plenty of aftermarket accessories are available, including a sprung solo seat and a sleeker drag-style handlebar. This air-cooled cruiser doesn't reinvent much of anything, but it certainly captures the imagination of chopper lovers who pine for the past—and is available at a reasonable price. Considering its lazy suspension geometry and intentionally unmodern mechanics, the Seventy-Two feels bicycle-thin and handles reasonably well. Our time spent cruising the industrial back roads of South Los Angeles seemed especially well-suited to the Seventy-Two; with its snappy bark and mellow vibe, the Seventy-Two charmed us into taking it easy. — BASEM WASEF



PRIUS LITE

Toyota's grip on the hybrid market—the Prius nearly outsells all other hybrids combined—is about to get tighter. The latest Prius offspring is the “c,” the smallest, cheapest, and most efficient Toyota gas–electric. Based on the compact Yaris platform, the c relies on a downsized Prius powertrain. The gas engine is smaller (1.5 liters instead of 1.8), as are the CVT transmission and the nickel-metal-hydride battery pack. Consequently, the c is about 540 pounds lighter than the regular Prius (now called the Liftback). Peak power, including the electric boost, is just 99 hp—enough to maintain highway speed, but it's leisurely off the line. The c is sufficiently nimble in tight urban confines, but it doesn't have the beguiling dynamics of, say, a Chevy Sonic. For those who delight in monitoring fuel saved (the c is stellar in this regard, achieving a 53-mpg city rating), the trip computer provides plenty of entertainment. There are several ways to view efficiency, and drivers can even input fuel-economy data from other cars to obtain a real-time measure of gallons and dinero saved. Plus, the c is the first Toyota hybrid available with the cloud-based Entune mobile-app software. All of this gadgetry points to the fact that the joys of a Prius have little to do with actually driving it.

— LARRY WEBSTER

2012
Toyota Prius c
\$18,950

2012
Harley-Davidson Seventy-Two
\$10,499

2012
BMW ActiveHybrid 5
\$61,845



HY-FIVE

BMW's ActiveHybrid 5 is a slick example of how hybrid technology doesn't have to be a driving enthusiast's enemy. Tacking a 55-hp electric motor onto the stout turbocharged inline-six-cylinder combustion engine does more than increase efficiency—it boosts performance. Though the ActiveHybrid 5 is only available with an eight-speed automatic transmission, the electric motor provides its full 155 lb-ft of torque at liftoff. The result is a six-cylinder car that jumps off the line like it has a V-8 (0 to 60 mph in 5.7 seconds), yet it should get 20 percent better fuel economy (low 30s on the highway) over the standard 5 Series. Furthermore, the eight-speed automatic is programmed so that shifts, especially downshifts, are quick and responsive. The handling isn't quite as sharp as that of nonhybrid models, probably because of the extra 300 pounds, but it's still one of the most satisfying large sedans available. The ActiveHybrid 5 strikes a great balance between efficiency concerns and the performance that is inexorably tied to BMW's 5 Series. — JAMES TATE



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*EPA-estimated 17 city/25 hwy/20 combined mpg, EcoBoost AWD. Artwork for display purposes.

New Cars TEST DRIVES

AN EXPENSIVE TOY

Last year Mini added its smallest car yet, the two-seater Coupe, to its ever-expanding lineup. Now there's a convertible version dubbed the Roadster. That's a bit of an odd name since the word roadster conjures images of rear-drive convertibles like the Mazda Miata, not blocky front-drive conveyances. The Roadster, however, performs. All three trims feature one of the most impressive four-cylinders available today. Turbocharged in the John Cooper Works edition, the 1.6-liter churns out up to 208 hp. And there's also an Overboost feature that allows the turbo to generate more boost—for about 12 seconds—that kicks up the peak torque from 192 to 207 lb-ft. The six-speed manual glides easily through its gates (an automatic is optional) and the chassis is sharply tuned. You certainly don't forget that the front wheels are powered, but when the road curves, the Mini can hold its own with the Miata. Unlike the Miata, the Mini's top collapses into a deep well behind the seats, making it difficult to operate from the driver's seat. Shorter drivers will need the optional power top. The base 121-hp Roadster is reasonably priced, but beware: With higher trim levels and options, the sticker can approach 40 grand. — JAMES TATE



2012
Mini Roadster
\$25,050

2013
Hyundai Genesis Coupe
\$24,250

2012
Hyundai Azera
\$32,000



○ HYUNDAI'S PONY PICKS UP THE PACE

If the essence of the ponycar paradigm is lots of horses hauling a relatively lightweight buggy, the 2013 Genesis Coupe shows that Hyundai gets it. Mostly. There's still no V-8, but there are big output increases for both engines. A new twin-scroll turbocharger (the turbine is segmented and fed by pairs of cylinders for quicker response) and an enlarged intercooler boost the standard 2.0-liter four from an anemic 210 hp and 223 lb-ft of torque to 274 and 275, respectively. Direct fuel injection raises the optional

3.8-liter V-6 (\$28,750) to 348 hp and 295 lb-ft. To handle the extra power, Hyundai also made suspension tweaks. A six-speed manual continues as the standard transmission, but a new eight-speed is the automatic option. Fuel-economy estimates are higher, too: 21 mpg city, 30 highway for the turbo four and 18/27 for the V-6. Exterior updates include a redesigned front fascia and hood. Inside, a new dashboard and center stack, electroluminescent gauges, and upgraded materials improve comfort and appearance. — TONY SWAN



○ A SWEET SCOOP OF VANILLA

Five miles of freeway cruising is enough to understand the essential character of the new Azera. Squint just a little and it's easy to imagine yourself in a Toyota Avalon. Lots of comfort and convenience. Lots of room, front and rear. Lots of safety features. Quiet operation. Respectable power and fuel economy (EPA projections: 20 mpg city, 29 highway). Competent dynamics and steering. But minimal driver involvement. The similarities are no coincidence: The

Avalon was a key Azera development target. Still, the Azera one-ups the Avalon and some other rivals in a few key areas. Hyundai's styling provides excellent aerodynamics (0.28 coefficient of drag), making some competitors appear bulky. And the Azera offers plenty of standard equipment baked into its base price. There's one engine, a 293-hp direct-injection V-6; one transmission, a six-speed automatic; and only one option package. — T.S.

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New Cars BRZ VS MIATA

SPORTS CAR SKIRMISH

2013 SUBARU BRZ

2012 MAZDA MIATA



Subaru claims its new BRZ is feathery light, quick off the line, and a better handler than just about any car this side of a Porsche Cayman—and does it all for around \$25,000. In the sports car world, them's fightin' words. Because the Miata has been delivering sports car fans that same fun formula for the past 20 years, it was time for a showdown. We took both to the twisty roads deep in the Santa Monica Mountains to find out which is better. Can the Subaru outgun the benchmark affordable sports car? **BY BEN STEWART**

the CARS

The Miata is a classic convertible that looks to the past, aping the British roadster tradition of half a century ago, although our test car had the ingenious power-folding metal roof. The BRZ appears as though it's been rendered expressly for a starring role in *Gran Turismo 6*. It's also a four-seater, which is largely the reason for the 10 inches of length over the Miata.

Even though these cars appear different, there are plenty of similarities. Both use 2.0-liter four-cylinder engines with six-speed manual transmissions, and both power the rear wheels.

On the inside, the Miata is like a snug-fitting T-shirt. The BRZ is much

roomier, and some will find it far more comfortable. The Subaru also has more headroom, comes with supportive STI-like seats, and has a fat steering wheel unmarred by stereo controls. You sit a bit taller in the Miata, and that creates an exceptional view of the car's corners—and the road ahead.

If you need to haul a lot of stuff in your Miata, think again. It has no storage space behind the front seats, and the trunk is a small 5.3 cubic feet. The Subaru's more useful, and with the rear seats folded it can carry two golf bags or a full set of race tires. But even though the BRZ has room for four, don't bother trying to sit back there unless you're of leprechaun proportions.

the DRIVE

According to the spec sheets, the BRZ and the Miata are well-matched, but on the road they have vastly different personalities. On a sunny day with the top down, there are few better places than the Miata's cockpit. It's a little down on power compared with the BRZ, but that simply provides an excuse to frequently row the wonderfully mechanical shifter and keep the melodious motor at peak revs. The Miata dives into traffic gaps unsuitable for larger cars. Likewise, the BRZ is an expert at the daily cut and thrust. The shifter requires a bit more effort, but it's so accurate you'll never flub a gear change. Like the Miata, the BRZ favors high rpms. Although the exhaust note is a bit coarser, this engine



2013 Subaru BRZ		2012 Mazda Miata
\$25,000 (est.)	< BASE PRICE/AS TESTED >	\$28,550/\$32,640
200 hp, 151 lb-ft; 2.0-liter flat four/6M	< POWERTRAIN >	167 hp, 140 lb-ft; 2.0-liter inline four/6M
101.2	< WHEELBASE (IN.) >	91.7
166.7	< LENGTH (IN.) >	157.3
2760	< CURB WEIGHT (LB) >	2600
55/45	< WEIGHT DISTRIBUTION (%) >	51/49
13.80	< POWER TO WEIGHT (HP/LB) >	15.50
215/45R17	< TIRES (F/R) >	205/45R17 2
	ACCELERATION (SEC)	
2.40	< 0-30 MPH >	2.35
6.72	< 0-60 MPH >	7.06
17.53	< 0-100 MPH >	19.53
5.23	< 40-70 MPH >	5.62
15.03 @ 92.66	< QUARTER-MILE >	15.25 @ 89.41
	BRAKING (FT)	
29.57	< 30-0 MPH >	29.85
120.02	< 60-0 MPH >	121.67
	EPA FUEL ECONOMY	
24	< CITY >	21
30	< HWY >	28

BOTTOM LINE

freely spins to the lofty 7400-rpm redline.

The Miata's relatively soft suspension sucks up the worst potholes and rough road surfaces. The BRZ is firm—perhaps not exactly too firm, especially for true sports car nuts—but if our commute included lots of potholes and frost heaves, we'd grab the Miata keys. Yet the BRZ is quieter and fits more stuff, so for a long road trip—especially one where mountain rides are involved—it's the easy choice.

Driving the Miata on the canyon roads near Malibu we got into a satisfying rhythm connecting the scintillating curves. There's such harmony between the driver and this chassis that it makes the Miata easy and fun to drive. But work the Miata harder, to the edge of its capabilities, and that balance goes away. The body rolls and bobs around on its suspension and the car becomes a little flustered. Although these two are nearly equal in a drag race, the Miata simply cannot catch the BRZ on a snaky road. The Subaru's firm suspension and robust chassis work together to make the car an absolute animal in this terrain. The Subaru bends into a corner so aggressively and with such mastery that it almost makes it boring to drive at anything less than its limit. If you do get into trouble, the stability-control system responds instantaneously. The system corrects any mistake quickly, then lets you get back to driving. The Miata relies on older tech for its stability control, and it feels more intrusive.

But there are roads that perfectly fit the Miata. On the tightest and roughest curvy road we could find, the Mazda's supple suspension handled the bumps that threw the BRZ off course. If the road is bumpy or undulating, the Miata's the master.

It's clear after a week of hard driving that the new Subaru BRZ is the more capable-handling machine. The BRZ is quicker in just about any situation, provides serious feedback for the driver, and is the ideal track-day partner. The Miata's not quite as sharp, but here's the caveat: Its performance bandwidth is

perfectly tuned for the normal below-the-limit driving we do most of the time. For a swift cruise down a country road, few cars can match the Miata's charisma. The BRZ's top may not retract, but there's three times the cargo room, and it makes any driver feel like a seasoned pro. This one's a close call, but the Subaru wins.

(RE)DESIGN CLASS

Ford is on a mission to restore Lincoln to its former glory. For some extra inspiration, the carmaker recently challenged students at Detroit's College for Creative Studies to design a Lincoln for the year 2025. *BY ANDREW DEL-COLLE*

WHEN FORD KILLED MERCURY

but kept Lincoln alive in 2010, it was clear the automaker still had hopes for the struggling luxury brand. That same year, Max Wolff became Lincoln's first-ever design director, tasked with revitalizing the brand's image. Previously, Wolff had been a pivotal member of the Cadillac team during its own design overhaul. Fresh styling cues, such as Lincoln's waterfall grille, have trickled into the lineup over the past few years, but the **MKZ concept**, which debuted at the 2012 Detroit auto show, was supposed to show off a bold new design direction. Reviews, however, were mixed.

Now Wolff and his team are not limiting themselves to their own ideas. They recently teamed up with the transportation design department at the College for Creative Studies in Detroit to mine the minds of the industry's next generation of designers. To provide real-world experience for the students, CCS classes often collaborate with carmakers on design projects, but the relationship is mutually beneficial: Automakers scope out top talent and reap a little inspiration in the process.



The MKZ's sweeping roofline, clean surfaces, and raked split-wing grille exemplify what Lincoln design director Max Wolff refers to as elegant simplicity.

For fall 2011, Ford and Lincoln challenged CCS students in the senior studio class to design a 2025 Lincoln with seating for four or more. Each student had to select a target market for the vehicle, and the design had to be viable (sorry, no fusion-powered carbon-fiber coupes this time). They then spent two weeks researching, six weeks sketching and rendering, and six weeks creating one-quarter-scale clay models. Each week members of the Lincoln design team would drop in to provide guidance. At the end of the semester the school selected four of the top models for exhibition at the 2012 Detroit auto show. These are the four models that made the cut, with an explanation straight from the students' mouths.



BRIAN MALCZEWSKI, 22



"The inspiration came from Chris-Craft—antique wood boats," Malczewski says. "I felt like that was the perfect inspiration because it kind of represents this iconic American styling that I really wanted to bring to the car." For Malczewski, keeping Lincoln distinctly American is important as other luxury brands mimic European styling trends from BMW, Audi, and Mercedes-Benz. Some of the Chris-Craft features Malczewski incorporated include a dramatic side curvature from front to back, a chopped-off rear, and sharp section lines. Malczewski also kept fuel efficiency in mind, designing his sportback around a twin-turbo V-6 or even a turbo four-cylinder with a hybrid motor.



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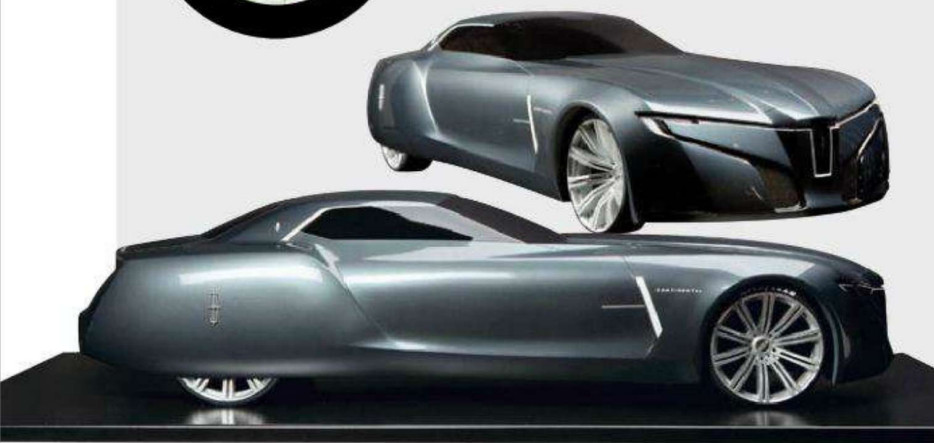


New Cars LINCOLN DESIGN CHALLENGE

JAE HAN SONG, 28



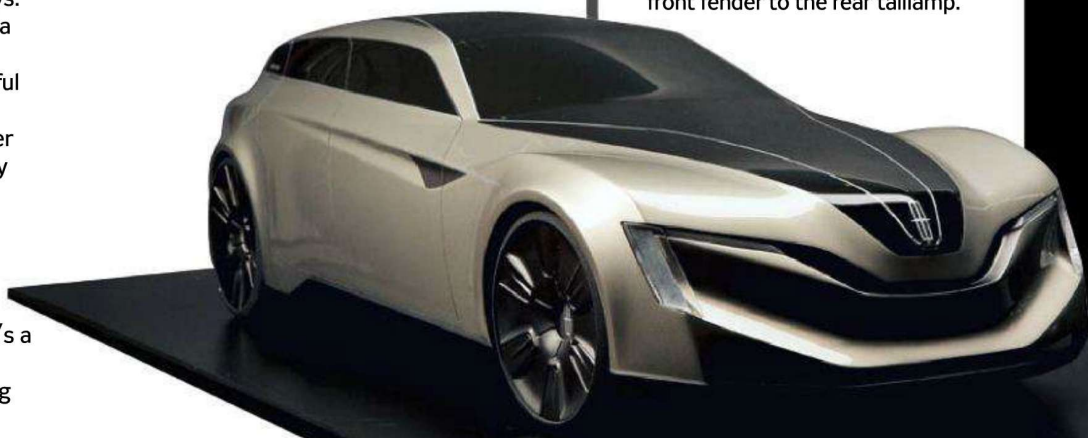
Like many of his fellow students, Jae Han Song found inspiration for Lincoln's future look in the classic 1956 Continental Mark II Coupe. "I was going to make the new version of the Lincoln Continental Coupe and kind of revive American luxury," Song says. For a touch of old school, Song covered the rear wheels, and he says the long hood is meant to emphasize the powerful V-8 that's supposed to be housed within. But it's the grille that might offer the most distinctive styling cue on Song's updated coupe. "It's inspired by an American eagle's wings," he says.



ALEXANDER MCGOWEN, 21



"I really wanted to design a car that would push the Lincoln brand back into that prestigious status that they used to have," McGowen says. To achieve this, he designed a classically proportioned car with a low, wide, and powerful stance. He calls it a grand luxury coupe, and the 7.0-liter V-8 he has in mind will supply plenty of power. McGowen believes one of Lincoln's biggest hurdles is its dependence on Ford architecture. "That's where my car kind of came in," McGowen says. "It's a really big luxury coupe, and Lincoln doesn't have anything like that. They don't have a platform for it right now."



DONGWAN JO, 29



Dongwan Jo's fully electric sports wagon with a solar-panel roof is intended for sale in India, where sports wagons such as the BMW X1 are popular. For design inspiration, Jo used the lotus flower, an important symbol in Indian culture. But he also kept aspects of traditional Lincoln styling. "The horizontal line is a key design feature of Lincoln, so that's why I chose that horizontal rear lamp," Jo explains. For the front lamps, Jo says he went for a more luxurious yet aggressive look. He also wanted the vehicle's lines to be strong but light, which he says can be seen in the line extending from the front fender to the rear taillamp.

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New electronic lure may catch too many fish; one state bans it.

A bass every seven minutes.

by Mike Butler

NEWARK, DE – A new fishing technology that set a record for catching bass in Mexico is now showing its stuff in the U. S. It has out-fished shrimp bait in Washington State and beat top-selling U. S. lures three to one in Florida. The new technology is so effective one state, Wyoming, has banned its use.

The breakthrough is a tiny, battery-powered electrical system that flashes a blood-red light down a lure's tail when it's moved in water. Fish think it's an injured prey and strike. Some fishing authorities, like those in Wyoming, think that gives fishermen too much of an advantage.

They may be right. Three fishermen using a flashing lure in Mexico caught 650 large-mouth bass in just 25 hours. That's a bass every seven minutes for each person, and a record for the lake they were fishing. They said the bass struck with such ferocity they hardly lost a strike.

In Florida two professionals fished for four hours from the same boat. One used a flashing-red lure; the other used some top-selling U. S. lures. The new,

"bleeding" lure caught three times as many fish.

Before reporting this, I asked a veteran fisherman in my office for his opinion. Monday morning he charged into my office yelling "I caught six monster fish in an hour with this thing! Where did you get it?"

Then I phoned an ichthyologist (fish expert).

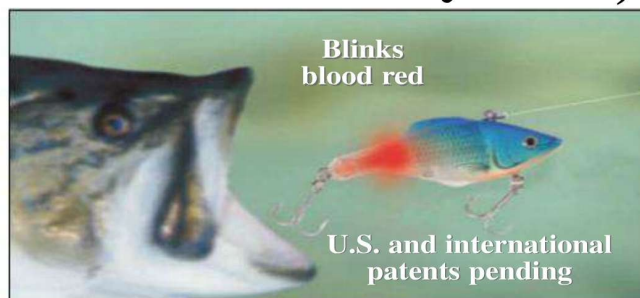
"Predators - lions, sharks," he said, "will always go for the most vulnerable prey. Fish are predators, so if a fish sees a smaller fish bleeding, it knows it's weakened and will strike."

"If a lure could appear to be a live, bleeding fish, a few fishermen could probably empty a lake with it."

I told him three almost did.

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PM'S REPORTER
LOOPS AND ROLLS
IN AMERICA'S ONLY
AEROBATIC HELO.

Chuck Aaron (below right,
with the author) modified
a German BO-105 heli-
copter to perform unique
aerial tricks.



Skids to the Sky

> BY JEFF WISE

> PHOTOGRAPH BY TOM PATTON

W

E'RE IN THE FRONT SEAT OF A HELICOPTER, thumping along 1500 feet above the foam-flecked waves of the Gulf of Mexico, when pilot Chuck Aaron does something you're never supposed to do. He pulls back on the controls and just keeps pulling. When the helo's nose rears up, I feel my body sinking into the seat as my heart crawls up my esophagus. We keep going until all I see is blue sky, then the line that separates it from the greener blue of the gulf. A little voice in my head is saying *huuuunh?* and the weight of an implausible yet true realization sweeps over me: The rotors are now below us, the landing skids above. We are flying upside down.

There's a reason why you should never, ever fly upside down in a helicopter: The rotors will bend toward the skids and cut off the tail and you'll plummet to your death. Helicopter rotors are designed to handle a lot of flexion, because each blade has to bend up and down as it moves into and against the slipstream. In normal flight, the blades bend away from the cockpit. But if you fly upside down, they flex in the other direction, giving a whole new meaning to the word chopper.

Aaron, a 63-year-old with a mane of golden hair and a bushy mustache fit for a

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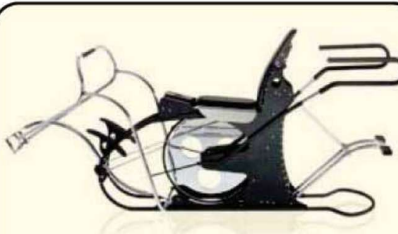
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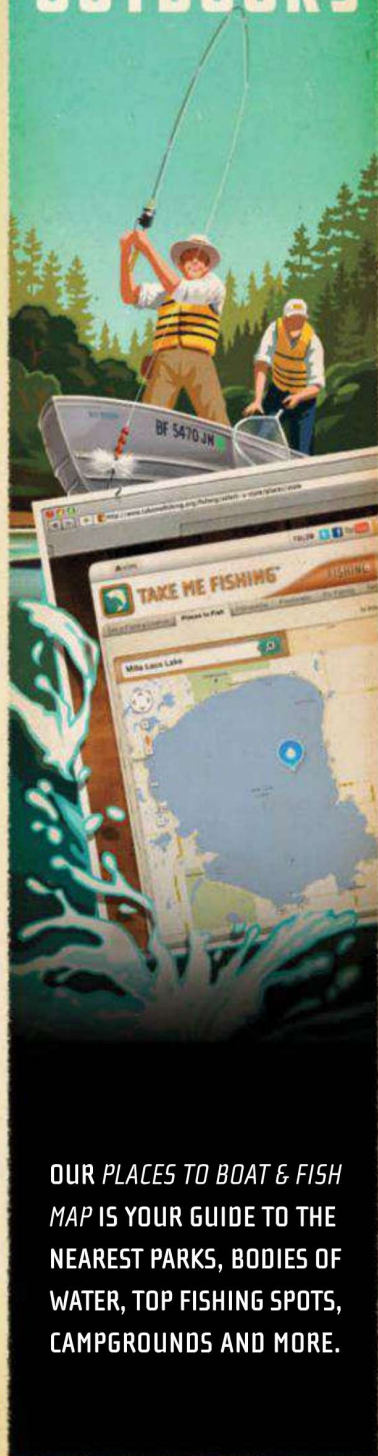
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P M

I'LL TRY ANYTHING///
UPSIDE-DOWN HELO

circus ringmaster, knows all about this. He was a helicopter pilot and mechanic living in Camarillo, Calif., when he got a call from Red Bull in 2004. They'd heard that he'd assembled a U.S. Army attack helicopter from parts scrounged on the open market. They asked him: Could he build a helicopter capable of looping the loop? "No," he told them. It was impossible. End of story.

But Aaron kept mulling it over, and he thought that if you took the right kind of helicopter and modified it in just the right way, you might wind up with an aircraft that could fly upside down. Red Bull gave him the money, and he bought a pair of German BO-105 helicopters with rugged one-piece titanium rotor heads and four short, stiff composite blades. After a year of modifications—he refuses to reveal the engineering details—he took his helo up.

Success did not come easily. For three months Aaron got to know the machine, testing its capabilities. But fear held him back. "I'd get vertical and I'd chicken out," he says. "But over time I kept going a little bit farther, and one day I pulled that sucker up and as I got to my chicken point, I did one of those instant things where I said, 'I'm going for it.' I pulled it straight back and I did the loop. As soon as I saw the ground I was like, 'I can get this!' So I pulled out of that and I did it again. I didn't want to forget how I did it. So I did it again and again—10 times." From that first loop he expanded his repertoire of maneuvers, and today he's the only civilian pilot in the U.S. licensed to perform aerobatics in a helicopter.

It's a cold morning in Pensacola, Fla., when I meet up with Aaron. A big air show starts tomorrow, and with the 20-mph winds, Aaron is debating whether to take part in the rehearsal. One time, he tells me, he almost killed himself trying to perform under similar conditions. This gives me pause, but Aaron assures me that we'll be fine if we go out over the water and try a few maneuvers. So up we go.

We launch from the Naval Air Station's ramp and pass over the beach.

Aaron climbs until he's above the barrier island that he'll use as a reference line to orient himself. Then he pulls up into the loop. In a matter of seconds we're over the top, then arcing downward. Aaron has discovered that this can be the most dangerous part. "If I keep it pointed down for too long, I'll build up too much airspeed," he says. "Then I'll have too many g's in the pull-out and rip the transmission off."

That doesn't happen today, I'm pleased to report. Aaron once again pulls up into a climb, then startles me by rolling over to the left until our bodies are parallel to the horizon. He keeps rolling until we're upside down, then brings us back up the other side. In a plane, the equivalent maneuver would be a mild trick called an aileron roll; in a helicopter, the procedure causes a disconcerting sensation, as if someone were holding you by your heels over the edge of a tall building.

Next, Aaron pulls back on the stick and waits for his airspeed to bleed off until we're nearly dead in the air. Then he pushes the stick forward. We're floating in our seats in a low-altitude approximation of NASA's Vomit Comet. A second later we're toppling forward. As we fall straight down Aaron rotates us 180 degrees on a vertical axis so our track is like the stripe on a barber pole, then pulls back so we level out.

Aaron keeps stringing together one maneuver after another: up, sideways, down—*whoop!* I'm starting to think about a barf bag as Aaron pulls out of a climb and turns us into the wind. He's about to unleash the ultimate.

"Zero airspeed," he says, gesturing at the instrument panel. "This is the back flip."

He pulls back, and back, and back. I briefly have the sensation of climbing as the windshield fills with blue, and then the uncomfortable feeling of toppling backward, falling upside down, hanging in my straps, a blur of disorientation. The helicopter has pivoted, heels over head, from a standstill—like a swimmer doing a back flip off a diving board. Then we're right side up again, barreling toward the shore below. My ears are filled with a piercing scream. It's coming from my own throat. It's a scream of pure, blind, mindless joy. **PM**

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WHAT
WENT

WRONG

By Barbara S. Peterson

CRUISE SHIP DISASTER

THE SINKING OF A
BEHEMOTH PLEASURE
VESSEL OFF THE
COAST OF ITALY
TURNS A VACATION
INTO A NIGHTMARE
FOR THOUSANDS.



The surreal sight of the Costa Concordia on Jan. 14, 2012, crippled and capsized off the Italian coast the morning after the accident, became an iconic image worldwide.

Antonello Tievoli, headwaiter on the *Costa Concordia*, stepped onto the bridge of the cruise ship at 9:15 pm on Friday, Jan. 13, of this year. From the wide windows, Tievoli could see the glittering lights of his home, Giglio Island, drawing closer.

Capt. Francesco Schettino knew that Tievoli's sister lived on Giglio, and invited him to the bridge as they cruised past. With its 13 brightly lit decks, the ship was more brilliant than anything on the island. The 4200 people onboard outnumbered the island's residents four to one.

The captain was no longer following his charted course—he had ordered the 952-foot-long ship to cruise at least 4 miles closer to the island. Insiders say that it was a special tradition for Costa liners to salute a beloved former captain, Mario Palombo, as they passed by his home on Giglio. The ship, which had earlier slowed down while Schettino lingered over a meal, accelerated to 16 knots, a brisk speed for a large vessel less than a mile from a coastline.

The ship's printed itinerary mentioned the island's proximity, but few of the 3200 passengers were looking outside. The *Concordia* left Civitavecchia, the port city of Rome, about 2 hours earlier, and the passengers were just settling into their vacation routines. Minnesota resident Ronda Rosenthal, who had stopped at her cabin before heading to a 9:30 pm performance by Martin the Magician, looked out her porthole and saw white froth. "The waves were cresting really high, and we could see lights in the distance," Rosenthal says.

"And I thought we are either going very fast or we are very close to shore."

Schettino spoke to Palombo, only to find out that his friend and mentor was at his winter residence on the mainland. But there was no turning back; the ship was on a direct course for the rocky coast.

9:40 PM // GOING OFF COURSE

Modern cruise ships have electronic charts that show their GPS positions on screens. Any deviation from the plan entered into this system usually triggers an alarm. "It is possible that he [Schettino] disabled this for the maneuver," says Ted Thompson, a retired U.S. Coast Guard captain and the senior VP of technical and regulatory affairs for the Cruise Lines International Association. "In changing the track line he would have disabled the alarm as well. He may have just turned it off and was going manually and visually."

Other equipment on the bridge could have alerted the crew to trouble—if they were paying attention. "Ships are equipped with fathometers

that let you know how much water is under the hull," George Borlase, a naval architect and maritime expert, says. "But at the end of the day, there is always the human factor that overlays technology."

Schettino said he believed that he was more than a half-mile from shore, still too close by the book but not dangerously so. GPS data later revealed he was less than 1000 feet from land.

At 9:45 pm, everyone onboard knew that something bad had happened: The vessel shuddered, and the passengers heard a loud grinding sound. Some later

FATAL COURSE

This infamous shipwreck was entirely avoidable. An initial bad decision to pass close to the island of Giglio cascaded into a tragedy that exposed the lack of preparation and professionalism of the officers and crew.

compared the feeling to an earthquake.

Rosenthal was watching the magic show when she felt the ship “lurching, like the ship was being put in reverse.” She thought it was a special effect of the performance until she saw an empty stage: “I looked for the magician, but he was gone.” The ship had hit a large rock in the Le Scolo reef off Giglio.

Seconds later the lights flickered and went dark. Rosenthal and her sister, an Army officer on leave from Afghanistan, headed to their cabin to get some sleep. An announcement over the intercom cited a “technical problem” with the generators and stated that power would be restored.

The impact tore a 160-foot gash in the port side. Seawater began pouring in through a hole as long as an Olympic-size swimming pool, flooding three or more of the ship’s seven watertight compartments. The generators shut down. The *Concordia* was in trouble.

Ships built after 2010 might not have foundered the way *Concordia* did with three compartments flooded. In 2008 the International Maritime Organization (an affiliate of the United Nations) developed new standards mandating that ships remain stable with more than two compartments flooded. *Concordia*, completed in 2005, was only required to meet 50-year-old standards that the international community had deemed out of date.

Minutes after the crash, the emergency lights flickered on. The ship was drifting away from the island, already listing to the port side. “Everything is fine,” crew members told passengers.

• 9:49 PM //

A DEARTH OF LEADERSHIP

More than a decade ago, the cargo and cruise industries overhauled rules in an attempt to prepare ship crews for calamity. The key to disaster manage-

ment is preplanning the response so it will be fast and organized. These plans rely on an established chain of command that divvies up responsibilities during a crisis.

That idea fell apart in the darkness on the night of Jan. 13. The captain, according to reports and video taken on the bridge just after the impact, did not seem to be directing the action or behaving as if he was in charge.

“What doomed the ship was the complete and utter lack of leadership at every point along the way,” says Capt. Harry Bolton, director of marine programs and leadership development at the California Maritime Academy.

Ninety miles north, officers on night duty at an Italian Coast Guard station in Livorno got their first alert from the police (who received panicked calls from families of Italians onboard) that a ship in nearby waters was in trouble. Italian Coast Guard Capt. Gregorio De Falco called the *Concordia*’s bridge, where officers told him, “It’s okay, it’s just a technical problem.” No mention was made of the gaping hole in the ship’s side.



LENGTH: 952 feet
HEIGHT: 177 feet
PASSENGER BEDS: 3780
CREW: 1100
ENGINES: 42-Mw diesel-electric
PROPELLERS: twin, fixed-pitch
CAPTAIN: Francesco Schettino



0 1/2 km

Route on Jan. 13

9:41:48 PM
 15.5 knots

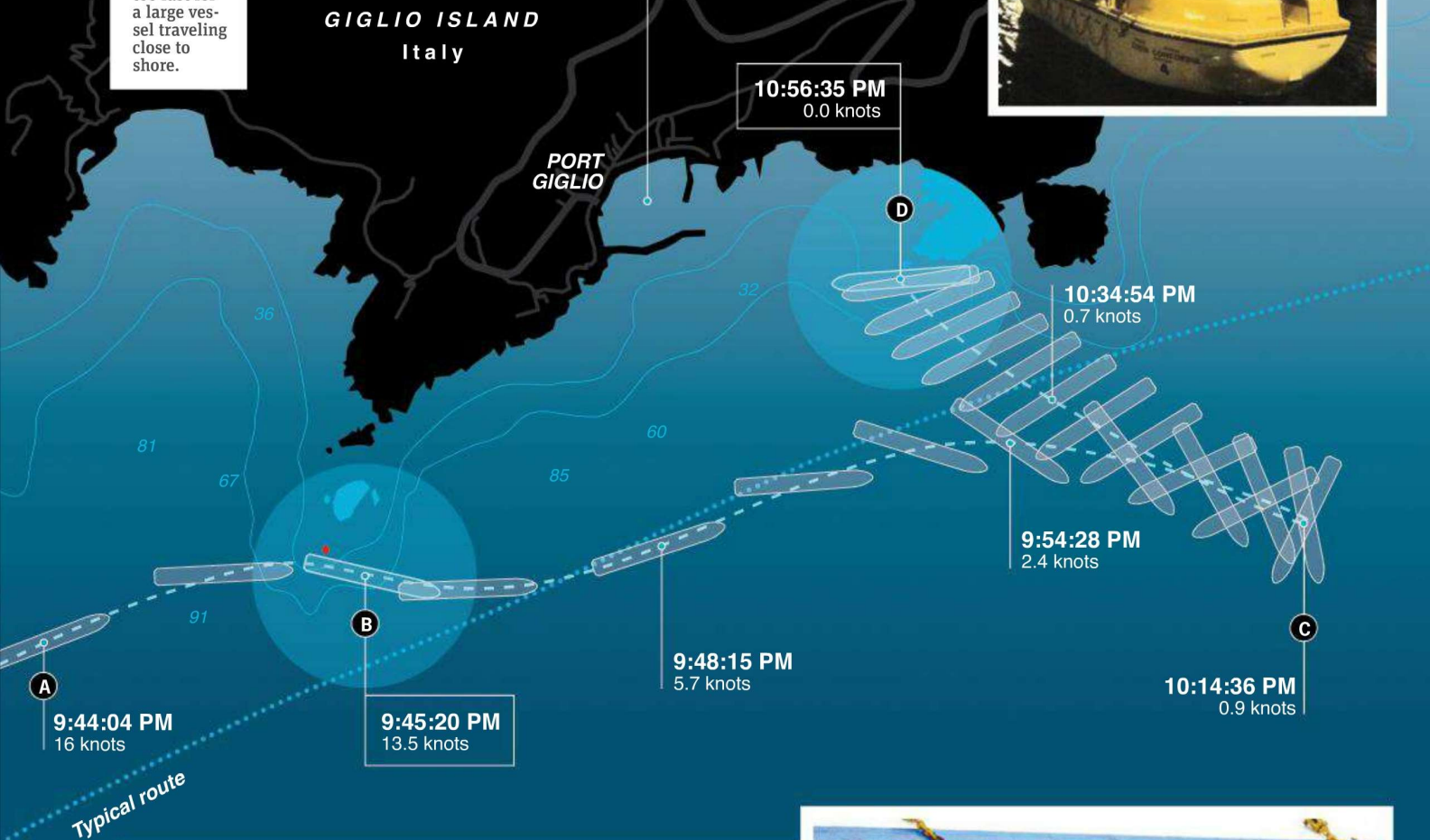
A Capt. Schettino steers at least 4 miles off his planned course. The maneuver—which has been performed before—is done to “salute” a colleague on the island. The ship’s speed increases to 16 knots, too fast for a large vessel traveling close to shore.

B The ship’s port side hits a rock about 900 feet off the Giglio coast. The 15-knot impact rips a 160-foot gash in the hull.

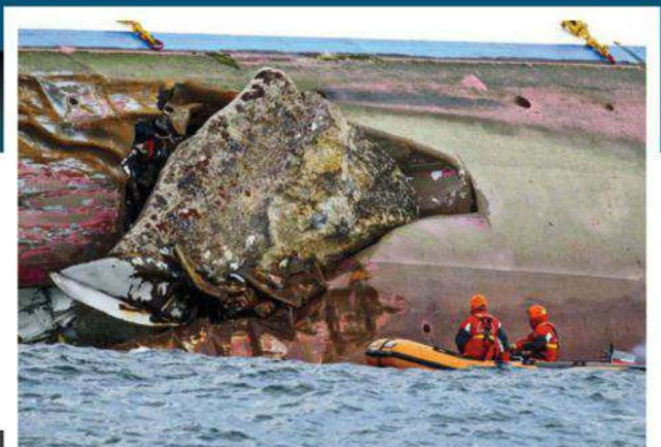


C The flooding ship loses main power. Schettino or his crew likely apply the remaining power to ground the vessel using its bow thrusters. Because of the shallow draught, the boat tips steeply.

D Almost 45 minutes after impact, an officer on the bridge shouts, “Captain, the passengers are starting to get into the lifeboats on their own.” Shortly afterward, Schettino orders an evacuation. The *Concordia* is listing so steeply that some lifeboats are inaccessible. The pitch also complicates their deployment. “We kept banging against the ship,” says passenger Nancy Lofaro, who took the cellphone picture of the lifeboat below. “People were screaming.” The ship capsizes in the shallows. The last passenger leaves *Concordia* about 3 am. Thirty-two people die from drowning or exposure.



Most of the passengers on the *Concordia* boarded that day for a pleasant trip along Italy’s western coast. (The maps have been rotated to show the ship’s track.) When the *Concordia* struck a rock—a piece of which remained embedded in the hull (right)—the voyage turned tragic.



PHOTOGRAPHS BY AP/WIDE WORLD PHOTOS (ROCK), CORBIS (PORT GIGLIO)

MAP METHODOLOGY // Nearly 10 years ago, ships were required to install transponders that reported their speed and position to other vessels within VHF range. A Dutch firm called Quality Positioning Services started installing onshore receivers that collected these signals. “We save the ships’ tracks,” says Scott Nesbitt, general manager of QPS’s Houston office. “We offer a playback of an incident to insurance companies during accident inquiries.” PM created the map above using QPS’s data, provided to local receivers every 5 seconds.

Map by Stamen Design

As it took on more water, the *Concordia* continued to list perilously. Dishes and silverware tumbled off tables; serving carts and other furniture slid down decks.

People emerged from their staterooms wearing pajamas and life vests. Crowds formed and confusion reigned; few knew the location of their lifeboat stations. That information would have been part of their muster drill, required by law to be performed within 24 hours of boarding. But the ship was in the first hours of its cruise, so the 696 passengers who boarded that day had no idea where to go.

The crew, lacking guidance and information, told passengers to stay put. "At this point, the crew was just as much in the dark as the passengers," says John Konrad, master mariner and founder of gCaptain, a maritime website.

Officers trained in the United States must take additional instruction, but virtually all cruise ships go to sea under a foreign flag and employ officers who were trained abroad.

• 10:15 PM //
MANAGING A
CATASTROPHE

Schettino, for all his other mistakes, seems to have done what he could to deliver his crippled ship to safety. "I like to say when I teach cadets, for every thing that goes wrong you have to do one thing right to fix it," Bolton says.

Ship groundings are rare but not unheard of, and they are rarely fatal. Just a week before the *Concordia* crash another large luxury ship, the *Poesia*, hit a reef off Grand Bahama Island, where it languished for more than 12 hours until high tide enabled



Most salvage operations start by removing the oil from a stricken ship. Not only is the fuel an environmental hazard, its weight prevents the salvagers from refloating the ship.

tugs to set it free.

There is anecdotal evidence—which will come to light when investigators release details from the ship's black box—that Schettino tried to stop the ship and waited for a similar tow to shore. If so, the anchor failed to catch.

Without its main engines, the *Concordia* drifted for an hour. GPS tracking data show the ship's speed dropped to near zero. It's not possible to steer a ship with no propulsion, Bolton says. Schettino still had options, though. "There's limited backup power from the auxiliary engines, which are usually located on a higher deck to minimize the risk of flooding," Bolton says.

About 30 minutes after the impact, Schettino appears to have used auxiliary power to engage the ship's bow thrusters. This is a standard method of docking, but Schettino may have used these to push the vessel toward land. The maneuver probably saved lives but had unintended consequences. "He was trying to get the ship to the shallow area where he thought it would remain upright," Bolton says. "He assumed wrong."

Nancy and Mario Lofaro from New Rochelle, N.Y., alarmed by the sharply pitched deck, ran to their cabin for coats and emergency gear. On the way, the ship lurched again. "There was a loud noise—everything went crashing to the floor," Nancy says. The *Concordia* had struck shore, where it was bound to capsize.

• 10:58 PM //
DELAYS COST LIVES

The captain gave the official order to abandon ship. By law, all 26 lifeboats have to be launched within 30 minutes of an evacuation order. But the crew's delay made an orderly escape impossible. By then the *Concordia* was tilting more than 20 degrees, rendering some of the portside boats useless. "The crew was too late and lost the window of opportunity," Bolton says.

Rosenthal and her sister were in one of the first lifeboats to drop from the ship. They arrived on the Giglio pier at 11:14 pm; on arrival a volunteer rushed up and asked for their life vests. They were told an estimated 500 passengers were trapped where they couldn't retrieve vests from their rooms.

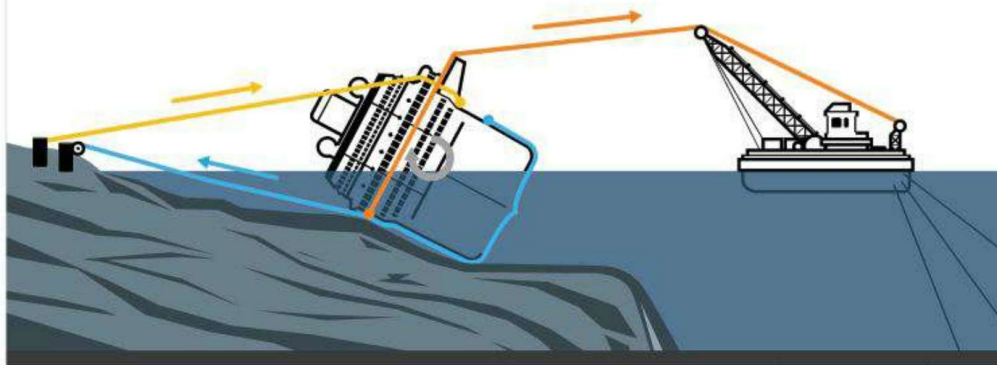
At around 11:30 pm, Schettino boarded a lifeboat

What doomed the ship was a complete and utter lack of leadership at every point along the way.

—Capt. Harry Bolton,
California Maritime
Academy director of
marine programs
and leadership
development

RIGHTING A SHIP GONE WRONG

and stability calculations,” says Tim Beaver, president of the American Salvage Association. “Engineers use these to create simulations.” Then hydraulic winches onshore and offshore pull the vessel by reeling in chains (blue and orange, below). A restraining line (yellow) unspools to keep the ship from tipping too far the other way.



(or, as he claims, fell into one) and headed to land, abandoning the ship and hundreds of passengers. Other officers onboard the *Concordia* reportedly followed suit, while some ferried passengers to land in the lifeboats.

Nancy Lofaro recalls the agonizing wait inside the lifeboat as crew members fumbled to lower it. The ship’s pitch made it nearly impossible to lower the boat into the water. “We kept banging against the ship,” she says. “People were screaming.” The craft settled safely into the water; it took less than half an hour to reach shore.

Schettino beached the *Concordia* in about 45 feet of water. When the ship finally keeled over, dozens jumped or fell off the ship, some in their evening clothes. The water was 57 degrees Fahrenheit—a temperature at which limbs become immobile in minutes and hypothermia can manifest within an hour.

• 12:42 AM // THE AFTERMATH

By then the Italian Coast Guard helicopters had pinpointed the wreck by its last transmitted GPS data and were spotting survivors with infrared cameras. Coast Guard helicopter pilots dropped harnesses to hoist more than 100 people clinging to the decks that were above water.

So, how do salvage experts float a capsized 114,500-ton cruise ship? If the owners want it whole, the ship must be patched, then drained of water and oil. “Modern ships come with electronic blueprints

Coast Guard officer De Falco tracked down Schettino on his cell-phone. The Coast Guard officer demanded that Schettino return but was rebuffed. “Perhaps you saved yourself from the sea, but I’ll make you pay,” De Falco shouted.

The *Concordia*’s death toll reached 25—some victims were still in their cabins—with seven missing. Schettino faces charges of manslaughter, and his first mate and several crew and Costa executives are also under investigation.

It’s hard to tease solutions to recurring problems from the actions of the *Concordia*’s officers. One lesson has already become

industry practice: Lifeboat drills are held before a ship departs, instead of within the first 24 hours of a cruise.

The *Titanic*’s sinking, despite the human errors that caused it, became a metaphor for unearned faith in technology. The wreck of the *Costa Concordia* may spawn a different moral: Beware the hubris of those in charge who may be taking your safety for granted. **PM**

SURVIVE YOUR CRUISE

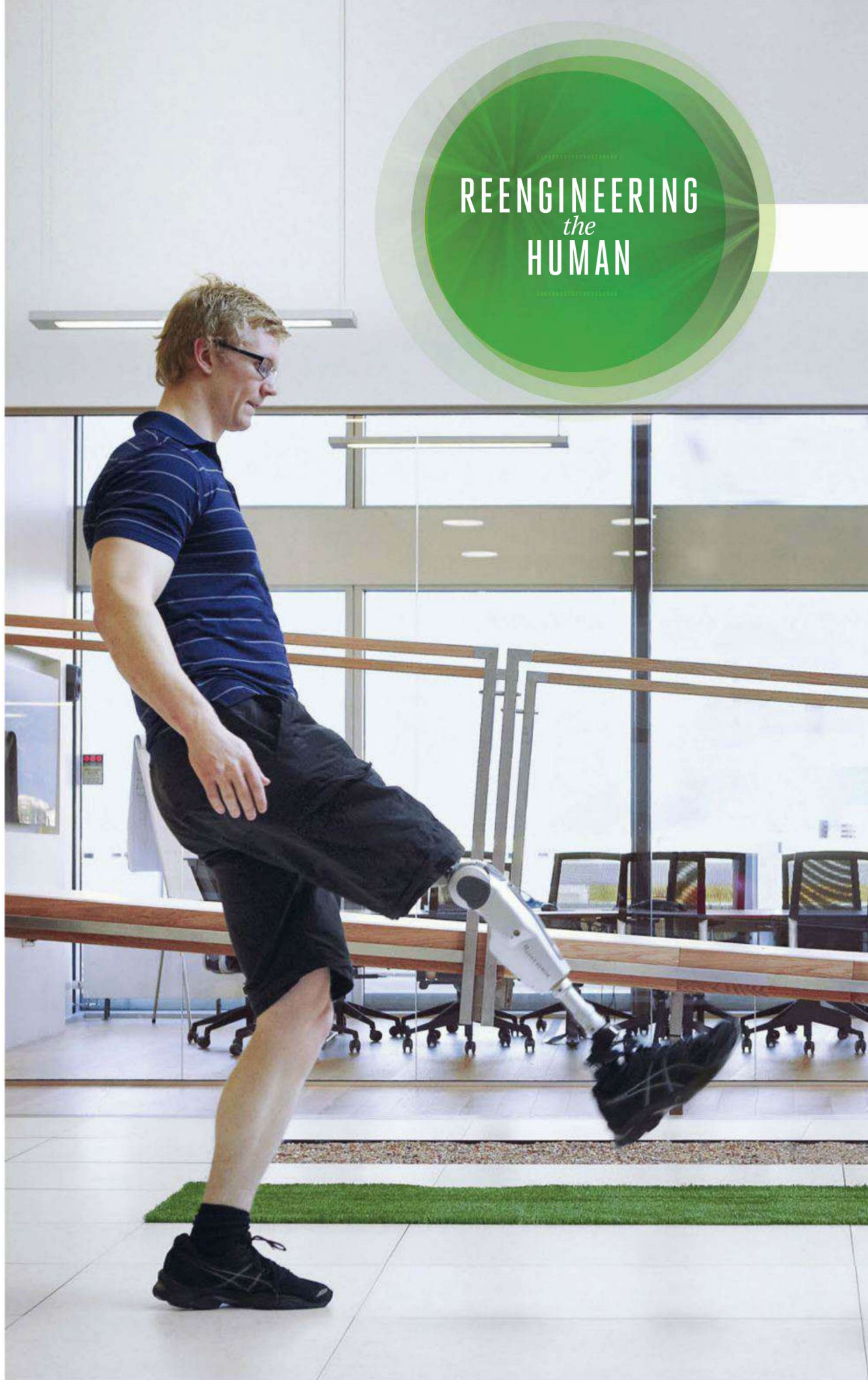
Vacations should be relaxing, but there are some simple ways to stay safe in case of a maritime emergency.

- Locate your life vest in your cabin as soon as you arrive; practice putting it on.
- Don’t wait for the required safety drill to memorize the location of your assigned lifeboat.
- Figure out how to get to your muster station—the place you should go to in case of an emergency—from any deck on the ship, not just from your cabin.
- Pack a couple of flashlights in case there’s a power outage.
- Recognize the evacuation signal. The standard alert is seven short horn blasts followed by one long one.
- Learn where life vests are stowed elsewhere on the ship in case you can’t gain access to your cabin.

• by ERIK SOFGE • photographs by NOAH SHELDON

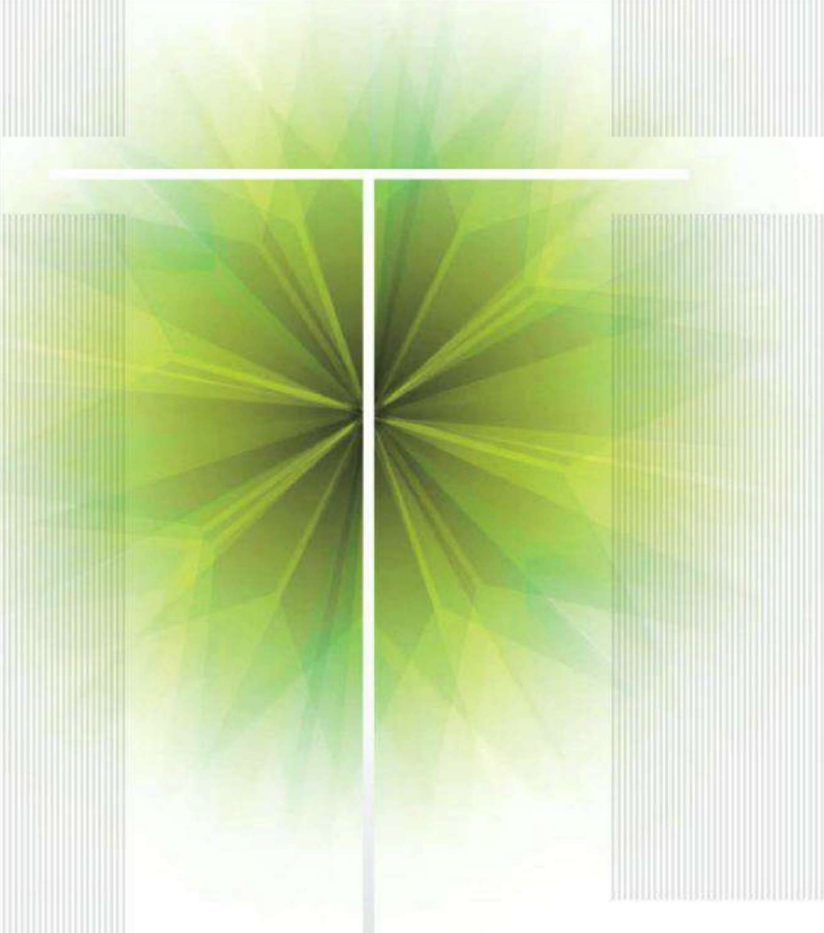
REENGINEERING *the* HUMAN

*
David Jonsson tests the Power Knee in Össur's Gait Lab. It's the only bionic knee on the market that powers itself forward. As an engineer at Össur, Jonsson is able to tweak prosthetic software and field-test the algorithms himself.



BIONIC LIMBS WITH MACHINE INTELLIGENCE CAN NOW SENSE THEIR ENVIRONMENT AND PREDICT A USER'S INTENTIONS. SMARTER, STRONGER, SPEEDIER ROBOTICS WILL SOMEDAY ENHANCE THE POWERS OF THE ABLE-BODIED TOO.





HERE AREN'T ENOUGH BIONIC MEN

on the planet to produce a proper stereotype. Even so, David the Farmer seems atypical. Ruddy, red-haired, and impossibly cheerful, he meets us on the gravel path outside his workshop. What I was expecting—a grizzled retiree limping stiffly through his daily chores—bears no resemblance to this 30-something mechanic climbing down from a massive tractor without hesitation, weaving between ATVs and scattered engine parts, moving from task to task with no evidence that he's part machine. After a few minutes, there are clues, though: He always turns on his right leg, and his pants gather around his left ankle, hinting at a limb that's slightly skeletal and decidedly nonbiological.

Today that left leg will be replaced. That's why engineers from Össur, one of the world's largest prosthesis-makers, drove an hour west from the company's headquarters in Reykjavík, Iceland, to the farm where David Ingvason lives and works. David the Farmer—the nickname they've given their star prosthesis tester, though he is actually employed as a full-time, on-site mechanic—is one of a limited pool of amputees fitted with the Symbionic Leg: an artificial knee, ankle, and foot that are integrated into a single bionic limb.

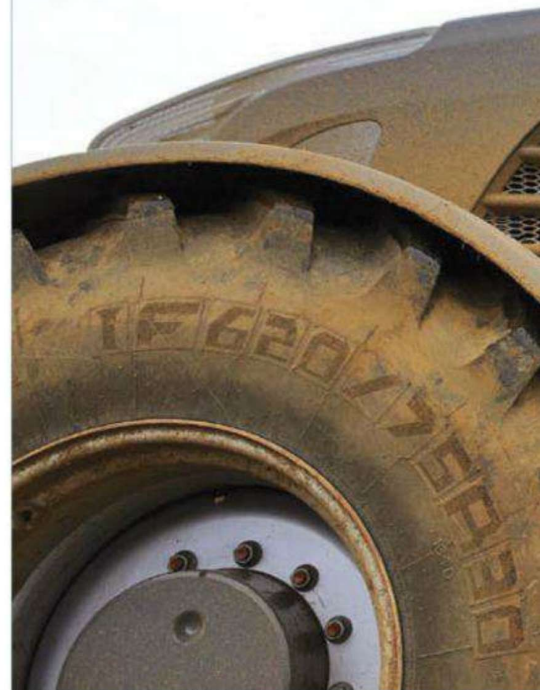
On the farmland and surrounding terrain, in tall grass, and on moss-sprayed plains of volcanic rock, Ingvason regularly destroys his leg. He fouls the motors in muck and sludge, burns them out through unremitting use, and generally grinds one of the most sophisticated auto-adaptive devices on the planet, each one worth more than some sedans, into an inert, cybernetic paperweight. According to Össur's new technology search manager, Magnús Oddsson, all Ingvason has to do is call and they'll hand-deliver a new limb. More often, he swings by Reykjavík himself wearing a backup leg and asking for a repair or replacement. Whatever David the Farmer wants, he gets—the punishment he metes out to his leg, and the data that result, are simply too useful.

Össur began selling the Symbionic model as the world's first commercially available bionic leg last fall. It represents a significant shift in prostheses. The traditional half-measures, the stand-ins for lost limbs and senses, are now being imbued with machine intelligence. Ingvason's leg is, in fact, a robot, with sensors that detect its environment and gauge his intentions, and processors that determine the angle of his carbon-fiber foot as it swings forward. The same approach is being applied to prosthetic arms, in which complex algorithms determine how hard to grasp a water bottle or when to absorb the

impact of a fall. Vision- and hearing-based prostheses bypass faulty organs and receptors entirely, processing and translating raw sensor data into signals that the brain can interpret. All of these bionic systems actively adapt to their users, restoring the body by serving it.

Take, for example, one of the most common prosthesis failures. A mechanical knee typically goes rigid as the heel lands, supporting the user's weight, then unlocks when pressure is applied to the toe. If that toe contact comes too early the leg collapses under its owner. The Symbionic Leg isn't so easily fooled. Force sensors and accelerometers keep track of the leg's position relative to the environment and the user. Onboard processors analyze this input at a rate of 1000 times per second, deciding how best to respond—when to release tension and when to maintain it.

Since the leg knows where it is throughout each stride, achieving a rudimentary form of proprioception, it takes more than a stubbed toe to trigger a loose knee. If the prosthesis still somehow misreads the situation, the initial lurch of the user falling should activate its stumble-recovery mode. Like antilock brakes for the leg, the actuators will slow to a halt, and magnetically controlled fluid in the knee will become more viscous, creating resistance, as the entire system strains to keep the person from crumpling or toppling.



The result, Ingvason says, is that he rarely falls, or no more often than someone with two biological legs. He can drive ATVs, hike across glaciers, even ride a horse while herding sheep. "I don't have to think about it," he says. Before he went bionic, Ingvason fell constantly. "With the old knee, it was every day, often more than once in a day," he says. "If I was walking and the toe hit something while swinging forward and I stepped on it, then I just went down. Now I'm walking on uneven ground and high grass and sand and mud and everything."

Ingvason's newly delivered limb is another Symbionic Leg, loaded with upgraded software that will allow the knee and the ankle to communicate with each other. Össur plans to develop this feature over the coming years, establishing what Oddsson calls networked intelligence. After putting it on, Ingvason limps, awkwardly at first, across dirt and gravel, past the rusting hulks of trucks and cars. Within a few minutes, the robot has calibrated itself.

With Ingvason's pant leg hitched up, it's impossible not to watch the limb in action. It's harsh and alien. The gray polymer shell, which partially conceals aircraft-grade aluminum, seems too skinny to support his weight; the ankle, too delicate for the 10,000 newtons of force it was built to withstand. But the leg is nimble and so quick to react, it's as though he were born with it.

THE GOAL OF CURRENT BIONIC research is to recover what was taken. In Ingvason's case, it's the leg he lost nearly 12 years ago, when he stopped to help a couple whose car had broken down in the rain. While he was working, another vehicle slipped off the wet road and plowed into him. Others' losses include arms torn off by industrial accidents or improvised bombs, and senses dulled or snuffed out by disease. Despite decades of study, the prostheses developed to replace lost functions have been at once ingenious and disappointing.

Most prosthetic devices create their own health problems. Purely mechanical legs use a complex system of gears and analog triggers to allow people to walk, but users must hike up one hip with each step to keep the artificial toe from scraping the ground. Powered prosthetic arms tend to be locked in place during walking—and that dead weight

*
David Ingvason is a bionic leg's worst nightmare—the farm-based mechanic exposes the world's first integrated bionic limb to Iceland's most grueling conditions. On rare occasions he's been known to recharge it from a tractor's DC jack.



throws off the user's balance and posture. Roughly 70 percent of amputees develop back and joint problems, and experts suggest that such "comorbidities" force those who might be obese or in chronic pain to become even less mobile and less healthy, ultimately shortening their lives.

The answer, for now, is in the algorithms. Össur's Symbiotic Leg eliminates hip hiking through a simple robotic twitch: The toe actuates upward during each step, performing what's called dorsiflexion. Other algorithms are more sophisticated, interpreting a torrent of sensor data as specific types of terrain. If the foot lands at a higher elevation, with the knee bent, the leg assumes the presence of stairs and adjusts accordingly. If the toe tips up on contact and the heel dips down, the artificial intelligence (AI) suspects a slope and shifts the angle and resistance to assist in climbing.

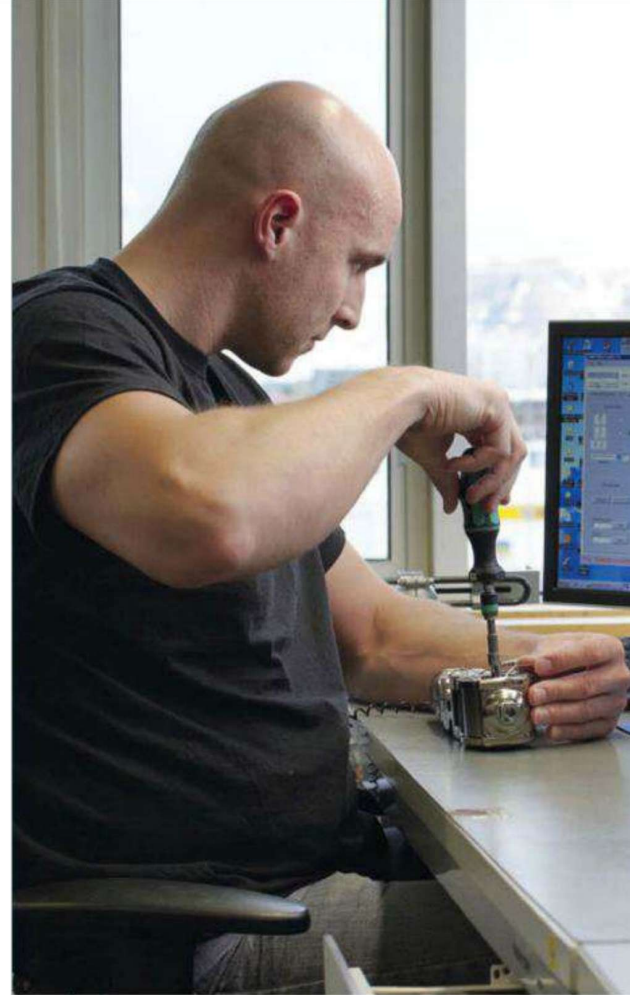
The new generation of prosthetic arms has a different set of software challenges and solutions. DEKA, the research firm founded by inventor (and 2009 PM Breakthrough Award winner) Dean Kamen, is developing the third generation of its bionic limb, known internally as Gen 3. It's backed by DARPA's Revolutionizing Prosthetics program—a \$100 million effort to create devices that are roughly equivalent in function to biological arms. Now awaiting FDA approval, Gen 3 has 10 degrees of freedom (typical motorized arms have only two or three) and a range of algorithms that mimic the precise control of its flesh-and-blood counterpart. By moving his or her foot, which operates a wireless controller, the user can engage various preset grasping patterns. Previous upper-limb models have used foot switches but with nowhere near the number of grip options, nor the machine intelligence and the force sensors that guide the artificial fingers and determine how much power should drive them. "The results have been incredible," says Stewart Coulter, the Gen 3 project manager.

"The other day, one of our testers was eating with chopsticks, doing a better job than I could."

The second arm funded by the Revolutionizing Prosthetics program, the Modular Prosthetic Limb (MPL), developed at Johns Hopkins University, may lead to what many believe is the endgame for bionics: direct neural control. By embedding electrodes into a subject's existing nerves, or going through the skull and implanting them directly onto his or her cortex, researchers have been able to turn thoughts into action. In a study conducted in 2010 at the University of Pittsburgh, a quadriplegic pressed the MPL's hand against his girlfriend's. Through trial and

✱

The Modular Prosthetic Limb looks like an advanced bionic arm. Really, it's a swarm of robots: Each detachable, motorized segment houses a processor that works in concert with the others.



error, processors are taught to decrypt a user's thoughts and recognize a growing list of intentions. "The system's smart. It has to be," says Michael McLoughlin, Revolutionary Prosthetics' project manager at Johns Hopkins. "The algorithms interpret what the patient is trying to do, then do it."

The MPL, in other words, isn't truly mind-controlled. The electrodes deliver orders, but it's the arm that decides how to carry them out. Or, rather, it's the network of machines—each jointed segment and finger with its own processor—that makes up the arm. The state of the art in powered prostheses is in some ways stranger than science fiction: a swarm of bots that obey the human mind, either through cables that snake out of the skull or by taking their best collective guess at those thoughts. Stranger still, this is just the beginning.

I TIP MY FOOT UPWARD. THE bionic foot that's bolted to the side of the table does the same. I press my toes into the floor and the prosthesis pivots downward into empty space.





*

An engineer at Össur runs diagnostics on the Rheo Knee's primary motorized joint. Part of the Symbiotic Leg, this prosthesis contains angle and force sensors that send real-time data to an onboard computer.



*

To reengineer organs such as the bladder (above), scientists at the Wake Forest Institute for Regenerative Medicine populate a biodegradable scaffold with a patient's own cells. Led by 2006 PM Breakthrough Award winner Anthony Atala, the team is now building more complex organs, like the liver and the heart.

It's mirroring what I do, responding to the vibrations in my calf muscles, which are picked up by silicone-embedded microphones strapped to my bare leg. The system isn't detecting the full-blown tremors of muscle activity but a set of lower-level, initial rumblings that begin when the subject first intends to move.

Unlike the tests run in Össur's Gait Lab, where users wearing sensor rigs climb ramps and cross gravel and sand, this research is happening behind closed doors. It's part of the company's own quest to find an alternative to invasive neural control. "What we would like to do," Oddsson says, "is exactly what the user wants. And for that we need some kind of a brain-computer interface [BCI]." Like other efforts, it's a work in progress: The 125 milliseconds it takes for vibrations to be processed into action is still painfully slow compared with the near-instant reflexes of a biological limb. A foot muscle can respond to input within 40 milliseconds—faster than even the brain can deliver a response. But it's a technology worth pursuing.

In the long term, experts agree that while implanted interfaces could change the lives of millions of patients with amputations, spinal cord injuries, or neurological disorders, bionics that require major surgery will always be expensive, niche devices. For the millions suffering from debilitating strokes, or people with no serious disability but the money to pay for a wearable bionic system, a noninvasive BCI would change everything.

In other words, it's how we could reach that persistent fantasy of the able-bodied—true bionic augmentation. Even the most evasive experts I spoke with agreed that, while visions of superhuman amputees may be ridiculous, a combination of noninvasive BCIs and exoskeletons could turn decades of bionic research into a mainstream tool. California-based Ekso Bionics released the first commercially available exoskeleton in February; it's designed for patients with neurological or spinal cord damage. Billed as a "wearable robot," the system walks under its own power, currently via a remote control. An ad-

vanced version translates shifts in balance and feedback from canes into a natural stride. "That's the right use of the technology now, as a medical device," Ekso spokeswoman Beverly Millson says. "But it's really a technology platform. It's the beginning of wearing your devices, for whatever purpose you might have."

At MIT's Media Lab, prosthetics pioneer (and 2005 PM Breakthrough Award winner) Hugh Herr is still in the early stages of bionic augmentation research, with a lower-limb exoskeleton system that cuts in half the forces associated with walking. Herr, who lost both legs below the knee as a teenager, understands the need for restoration. He's spun off a company, iWalk, to market his BiOM robotic ankle-and-foot system, now in clinical trials. Yet he says the endgame of his own work would be some kind of bionic vehicle that commuters might use to literally run to the office. Imagine sprinting 60 miles without breathing hard, across terrain that would stop an ATV in its tracks. "Something like the mountain bike will be completely laughable," Herr says. "We'll still have trucks to transport goods. At that point, though, driving alone across town in a metal box with four wheels would be just absurd."

Before leaving Össur, I coax a few specifics out of Oddsson. He's a scientist through and through. But he must have some sci-fi-tinged vision of what's beyond the Symbiotic Leg. He tells me he wants to take what Össur has learned about the human body and the intricacies of gait—the tremendous forces and physics at work in a single step—and create something that hijacks the nervous system directly. "It's not an exoskeleton. 'Smart trousers' might be more accurate," Oddsson says a little sheepishly. The goal at first would be to help stroke victims. The device would stimulate the muscles, providing commands that the brain or damaged nerves can't. "We would use the actuators that are already there, the muscles, and simply provide a new central controller," he says.

Eventually, Oddsson says, prosthetics research will disappear, replaced by advanced reconstructive technology. By 2050, he ballparks, limbs will be re-created—printed, grown, who knows?—and all of the arcane, biomechanical secrets collected by companies like Össur will be harnessed to finally restore flesh and bone. It's a strange best-case scenario: that an industry will innovate itself out of existence, its research seeding other scientific fields while all of that sophisticated technology migrates toward devices that change the way millions of us, abled or disabled, live and work. **PM**

THE FUTURE OF MAN AS MACHINE

EKSO BIONICS EXOSKELETON

In February, Ekso Bionics' exoskeleton became the first to step out of the lab and into the real world. This motorized robotic lower-limb system supports the full weight of users with spinal cord or neurological damage. Onboard batteries supply 3 hours of fully powered walking.

2012



SYMBIONIC LEG

The world's first integrated bionic leg, made by Össur, became available to select customers this past fall; sales will begin worldwide this year. The Symbiotic Leg self-adjusts everything from toe angle to knee resistance.

2012



BIOBOLT

Engineers continue to refine the next generation of this wireless device (tested in monkeys), which uses skin as a medium to transfer neural data to a bionic limb. The real breakthrough will be when the process provides sensory feedback. The hardest part will be writing the algorithms, says Euisik Yoon, principal investigator at the University of Michigan. "No one really knows what to say to the brain. Not yet."

2013



2015-2020

BRAIN-CONTROL RESEARCH GENERATES USEFUL SENSORY FEEDBACK, IMPROVING THE MAXIMUM LEVEL OF CONTROL IN UPPER-LIMB PROSTHESES.



GEN 3 ARM

DEKA's Gen 3 arm has 10 degrees of freedom and six preset grasp patterns. The company, led by Dean Kamen, plans to launch the arm with a wireless foot controller, though it could also accept commands from electrodes in the user's nerves or brain.

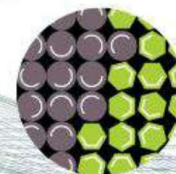
2013



2016



2017



2022

2013-2015

AFTER SUCCESSFUL HUMAN TRIALS, WIRELESS BRAIN-COMPUTER INTERFACE (BCI) SYSTEMS BEGIN REPLACING WIRED SYSTEMS, PARTICULARLY FOR PROsthESIS CONTROL.

MODULAR PROSTHETIC LIMB

Pioneered at Johns Hopkins University Applied Physics Laboratory, the MPL has 26 articulating joints. The first commercial version will likely be controlled via electrodes on or under the skin—but arms manipulated by sensors directly on the nerves and by brain implants are in clinical trials now.

ARTIFICIAL WHITE BLOOD CELLS

These tiny plastic "smart particles," called leuko-polymerosomes, mimic white blood cells, finding and adhering to infected cells. They can also be programmed to target specific cells and perform a variety of tasks, such as delivering a cancer drug. The University of Pennsylvania's Dan Hammer says the invention of more organically compatible parts could accelerate FDA approval from the current goal of five years.

PRINTED BONES

Washington State University scientists created a ceramic powder that they can use to print artificial bone scaffolds, employing a specially configured inkjet printer and CAD software. The scaffolding dissolves as natural bone grows around it. Lab-printed load-bearing bones, such as hips and knees, still remain at least 10 years off. "You have to really respect Mother Nature," chemist Susmita Bose says. "She is very, very hard to mimic."

ARTIFICIAL KIDNEY

An artificial kidney built at the University of California, San Francisco, replaces all the functions of the real thing in an implantable device about the size of a baseball. A series of nano-drilled silicon screens filter toxins out of the blood without the need for pumps or outside power. A bioreactor filled with specially engineered kidney cells performs other important renal functions, such as maintaining electrolyte balance. Bioengineer Shuvo Roy hopes to see it come to market in 10 years.

ARTIFICIAL RED BLOOD CELLS

Also called respiocytes, these robotic blood cells consist of about 18 billion atoms—most of which are carbon—in a diamond structure that's assembled one atom at a time. They could carry hundreds of times more oxygen than natural red blood cells, allowing people to hold their breath for hours or sprint at Olympics-level speeds for 15 minutes at a time. Robert Freitas of the Institute for Molecular Manufacturing hopes to have the first nanofactory up and running in 20 years.

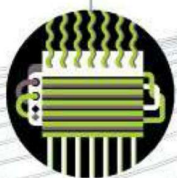
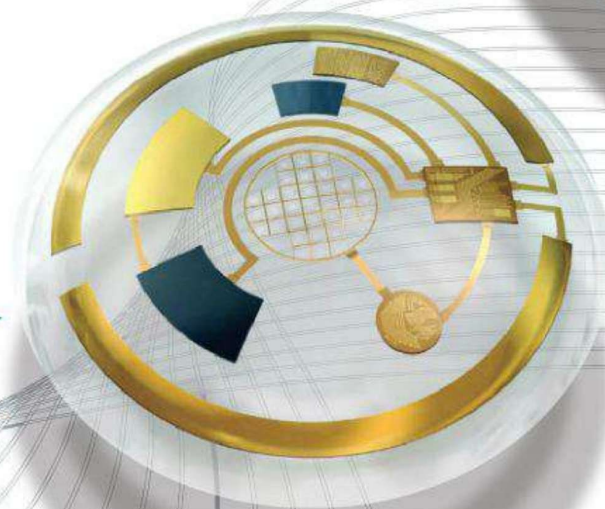
2022

BIONIC LENS

University of Washington researchers have been working toward a wirelessly powered on-eye display, aiming for a commercial version in 10 years. With micro-optics embedded in the lens, it could not only enhance vision, providing night vision or projecting data into the line of sight, but also restore some degree of lost vision. "For macular degeneration, the incoming image can be modified to be spread over the still-functional parts of a retina," project lead Babak Parviz says.

2022

2032



2025

EXOSKELETONS THAT AUGMENT SPECIFIC CAPABILITIES—SUCH AS STRENGTH OR SPEED—HIT THE MARKET, ALONG WITH RESTORATIVE ONES THAT RESPOND TO WIRELESS BCI.



2027

LAB-GROWN LIVER

Anthony Atala's team at the Wake Forest Institute for Regenerative Medicine has already implanted lab-grown bladders. Next up: more complex organs, such as the liver, grown from a patient's own cells on a scaffold. While a full implant is likely 15 years off, early work could provide injections of healthy cells or grafts of lab-grown tissue to repair damaged organs.



2050

PROSTHESES ARE NOW OBSOLETE, REPLACED BY RECONSTRUCTIVE TECHNOLOGY.



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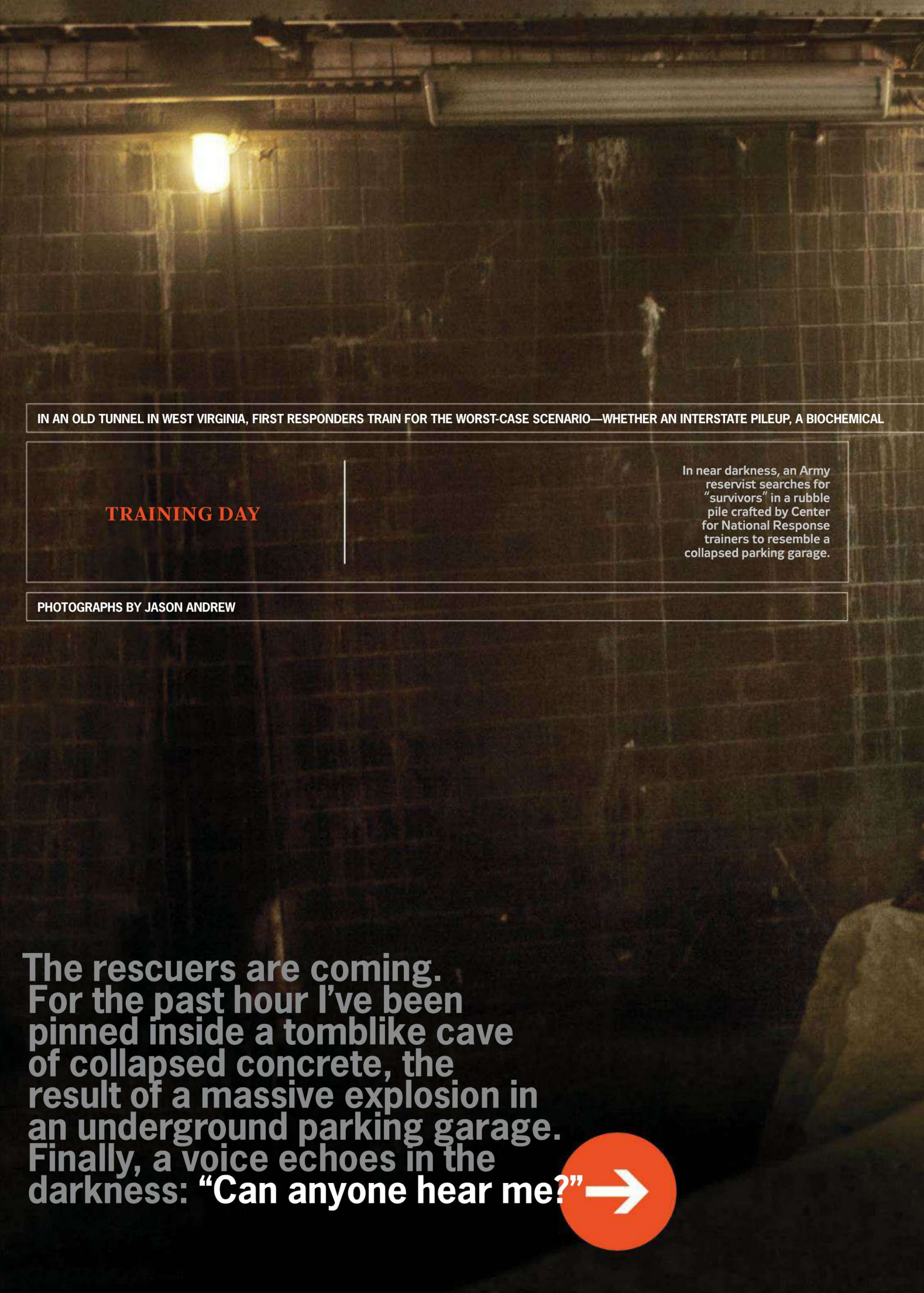
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IN AN OLD TUNNEL IN WEST VIRGINIA, FIRST RESPONDERS TRAIN FOR THE WORST-CASE SCENARIO—WHETHER AN INTERSTATE PILEUP, A BIOCHEMICAL

TRAINING DAY

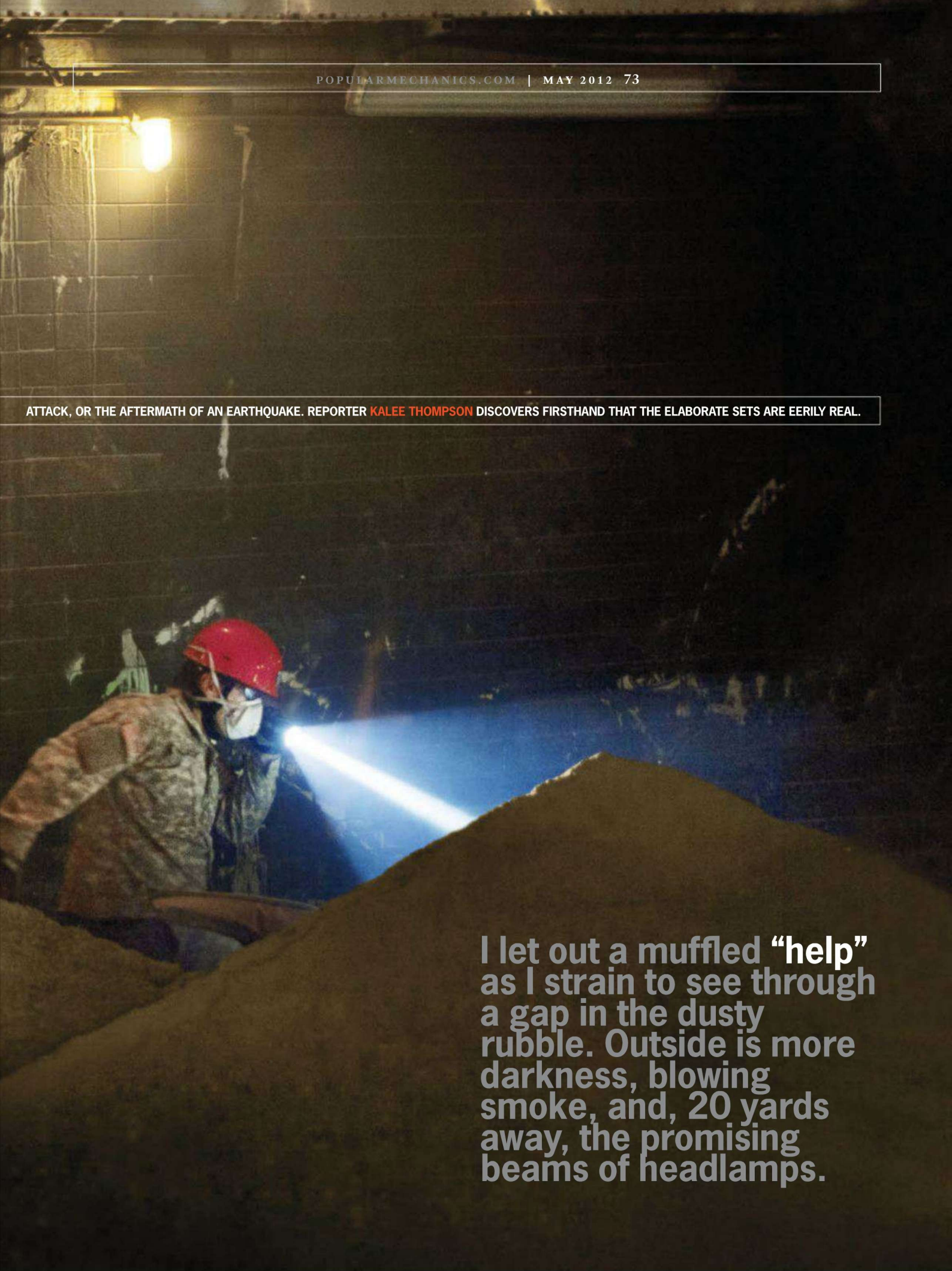
In near darkness, an Army reservist searches for “survivors” in a rubble pile crafted by Center for National Response trainers to resemble a collapsed parking garage.

PHOTOGRAPHS BY JASON ANDREW

The rescuers are coming. For the past hour I’ve been pinned inside a tomblike cave of collapsed concrete, the result of a massive explosion in an underground parking garage. Finally, a voice echoes in the darkness: “Can anyone hear me?”



ATTACK, OR THE AFTERMATH OF AN EARTHQUAKE. REPORTER **KALEE THOMPSON** DISCOVERS FIRSTHAND THAT THE ELABORATE SETS ARE EERILY REAL.

A person wearing a red hard hat and a tactical vest is crouched in a dark, dusty environment. They are holding a flashlight that illuminates a large pile of rubble in the foreground. The background is dark and appears to be a set or a real disaster site. A bright light source is visible in the upper left corner.

I let out a muffled “help” as I strain to see through a gap in the dusty rubble. Outside is more darkness, blowing smoke, and, 20 yards away, the promising beams of headlamps.

“Help,” I shout again. “Over here.” ¶ “Ma’am, we’ll be right there. We’re coming,” a young female voice bellows back in the dark. “Is there anyone with you?” ¶ “One, one more,” I scream. Sprawled out next to me in the dirt is a lifeless body, both legs twisted beneath it at impossible angles. In the distance, the sound of voices grows louder,

along with the growl of jackhammers and the crack of metal bludgeoning rock.

“All quiet,” a voice suddenly cries out.

“All quiet,” a chorus of several dozen repeats back in unison. Then, perfect calm.

“Ma’am, can you still hear us?” the young woman yells again, more clearly in the surrounding silence.

“My sister,” I cry.

“Is your sister still alive?”

“I don’t know,” I scream.

“All right. Stay calm,” she yells. “Ma’am, we’re with the U.S. Army Reserve. We’re here to help. We’re on our way!”

The smoke, the dust, and the

screams are real, but my sister is actually a vinyl dummy; my rubble cave, part of a complex set. I’m at the Center for National Response (CNR) in Gallagher, W.Va., where rescuers train to respond to domestic disasters inside an abandoned highway tunnel. A wide array of trainees—from National Guard, Coast Guard, and Air Force teams to police officers, EMTs, and firefighters—use the unique facility to learn to battle situations as diverse as earthquakes, terrorist bombings, train derailments, and highway accidents.

Today’s students are military, members of the Army’s 300th Chemical Company. I’ve spent the past few days watching them train under the direction of Dave Underwood, a tall, even-tempered former fire captain. Soldiers like these probably won’t be first on the scene in a big disaster, Underwood says, but they’ll provide the manpower and equipment to push on after the capability of local civilian first responders has been exhausted.

While the military has dozens of specialized training grounds nationwide, none is as versatile as the CNR for preparing specifically for domestic catastrophes. During my time there, several people refer to the facility as “a Disneyland for first responders.” The site includes 10,000 acres of dense woodland that hide a mock meth lab and a couple of rusty single-engine airplanes used to create crash scenarios. There’s a crowded lot full of trashed cars and trucks and a mountain of concrete blocks and rebar, all of it tools for the center’s dozen trainers. The CNR’s most valuable training ground, though, is the tunnel.

Chiseled into a mountain face in West Virginia coal country 60 years ago, the Memorial Tunnel was abandoned in the late 1980s when a new interstate was built nearby. In 2000, the property was acquired by the West Virginia National Guard and then converted into a multifaceted training facility with a staff that also takes its disaster-planning skills on the road. Today, the tunnel contains a mock train platform, several more illicit drug labs, a highway pileup involving a jackknifed big rig, a menacing plaster cave built to resemble mountain hide-outs in Afghanistan, and the only two subway cars in the state.

At the far end of the tunnel is the hulking pile of concrete where I’ve voluntarily trapped myself. Smoke machines and the same massive fans that served the original tunnel blow damp waves of dusty air while dimmable lights force the rescuers to work in near darkness. It is cold and desolate. Though I can see groups of trainees slowly moving toward me from the front end of the pile, behind me is nothing but mountains of rubble strewn with mangled bodies. It’s a carefully constructed landscape. “We can create any light setting that they want,” Underwood says. “We can make wind. We can smoke the tunnel or put flame bars out. We can give them the realism that they need.” Many of these soldiers have yet to see a war zone, never mind a major domestic disaster. The goal of the tunnel training is to get them as ready as possible for the real thing.





The Army's chemical companies were formed

during World War I, charged with creating clouds of smoke to obscure troop movements and bridge construction and demolition—maneuvers of conventional warfare that are now largely obsolete. (“The days of shooting rounds of mustard gas back and forth are over,” one reservist tells me.) As of January 2011, most chemical companies were officially renamed CBRN companies—for chemical, biological, radiological, and nuclear—and given a new mission: urban search and extraction. It’s part of a large-scale effort to train military forces to respond to domestic “white missions,” in addition to wartime “green missions.”

“Our goal is to improve upon our civil support to local firefighters and emergency-response units in a time of need,” Capt. Whinston Antion says. “You’re looking at soldiers going into collapsed structures, rescuing someone trapped in a building, cutting people out of vehicles.” The 300th is the first chemical company to complete an intensive 10-week search and extraction training. This week, three of its four platoons are reviewing and honing those skills. The fourth focuses its training on a more

The rescuers-in-training secure a mannequin in a Stokes litter after extracting it from the rubble. To add even more realism, local people are sometimes hired to play the role of victim.

traditional chemical company mission: hazmat reconnaissance. “Their main mission is to identify what a potential terrorist is trying to cook up,” Antion says.

The reservists’ three-day session follows a “crawl, walk, run” format. On the first day I watch as a group of young soldiers practices roping and rappelling skills, which could be used to reach victims after a building collapse. One of the reservists helping to run the training is a

Tunnel Vision

First built for the West Virginia Turnpike, this 2800-foot-long tunnel is now a versatile training ground for first responders.



METAL-CUTTING STATION
for plasma-torch practice

HIGHWAY ACCIDENT
involving cars, trucks, and a NYC Transit Authority bus

JACKHAMMER STATION
with concrete blocks for skills training

DRUG LABS
to simulate bomb building and illicit drug activities

baby-faced 21-year-old named James Hartman. As he spreads red climbing rope and carabiners across the blacktop outside the tunnel entrance, Spc. Hartman describes how this training has helped him in his civilian job as a volunteer firefighter. He recently extracted a car-accident victim using the Jaws of Life and also just completed his first rope rescue: "It turned out it was for a dog—a Lab that was stuck on a cliff. I strapped him in and hauled him up," Hartman says.

By the afternoon, the soldiers are rappelling off the face of the three-story tunnel. Given Hartman's obvious mastery of the climbing hardware and knots, I quickly agree to serve as a guinea pig for their mock rescue attempts. Hartman secures my harness and explains how I should keep my weight back and my feet planted against the wall as soldiers haul me up and over the lip of the tunnel's roof.

The next day I take a turn learning to slice through metal with a plasma torch, a tool whose safe use is demonstrated by a company member with a day job as a welder in a coal mine. The soldiers unpack brand-new axes, crowbars, and a 40-pound Jaws of Life metal cutter to rip apart a pile of crashed cars and extract the dummies that CNR staff have lodged inside. Terrorist attacks and natural disasters can also lead to situations where people become trapped in their cars. "Peel it like a can!" Staff Sgt. Josiah Saxe yells as a couple of soldiers struggle to pry off the rear end of a blue sedan.

Dummies recovered, my group moves on to the last station, where each soldier inserts earplugs, pulls goggles over his or her helmet, and attacks a concrete rubble pile with a jackhammer. Meanwhile, the recon platoon, dressed in puffy hooded hazmat-protection suits and back-mounted oxygen tanks, practices chemical sampling in one of the tunnel's mock drug labs.

Compared with many of the groups that train in the tunnel, these soldiers are amateurs. Ninety percent of the reservists have full-time civilian jobs; their normal commitment to the Army is one weekend a month and one two-week training session a year. But with thousands of troops nationwide, the Army chemical companies are poised to provide a lot of the muscle behind the broader military shift to white missions. The National Guard arguably plays an even bigger role. In the past few years the Guard has built up 57 Civil Support Teams, new groups of 22 full-time soldiers wholly dedicated to domestic disaster response. Those teams augment 17 larger groups known as CERFPs, each made up of approximately 180 part-time National Guardsmen. And as of last year, Homeland Response Force units, comprising more than 550 guardsmen, will serve each of the country's 10 FEMA regions. At a time when military budgets are shrinking, the shift represents a significant reallocation of resources.



At the Center for National Response, hazmat reconnaissance team members use an arsenal of handheld chemical detectors to identify airborne hazards.



The mandate to focus on domestic disaster

was largely a reaction to the Sept. 11 terrorist attacks. In the decade since, the reality has sunk in that these soldiers are more likely to respond to a natural catastrophe—or an accident. While at the tunnel, I hear references to Hurricane Katrina often. The devastating March 2011 Tohoku earthquake in Japan is on the trainers' minds, as are recent events close to home. Last year there were a record 14 U.S. natural disasters that each caused more than a billion dollars in damage, among them the monster tornado that hit Joplin, Mo., in May, and Hurricane Irene, which ravaged the Northeast in August. Meanwhile, there hasn't been another significant domestic terrorist attack since 9/11.

The design of the final day's tunnel exercise ends up reflecting exactly this disconnect between expectation and reality. First the soldiers would be briefed on a massive explosion at the student center at West Virginia State University in nearby Charleston. Just hours before, they'd be told, the university had denied a permit to a group of Islamic students who wanted to conduct a protest outside the building. Officials suspect a connection between the events. Midway through the exercise, the soldiers would receive new information: The local utility had determined that a massive gas-line leak was responsible for the devastation. There was likely no terrorism after all.

As Underwood and I climb into one of the CNR's four-wheelers and head toward the far end of the tunnel, he sounds more like a theater tech than a fireman: "We'll start with an eerie glow and light smoke," he says, his bright red Windbreaker luminous in the near-dark. We reach the hulking rubble pile, representing a collapsed parking garage beneath the student center. "The recon group will be semilit," Underwood says. "As the search and extraction teams arrive, we'll bring the lights up." Those power-tool skills are a little too new to attempt with headlamps alone.

We stop the four-wheeler and I scale the jagged pile of concrete, pulling on a spare helmet and a pair of work gloves. Underwood points out a couple of safe hiding spots; I choose one and lower myself into it. I've been hidden for close to an hour by the time that first rescuer reaches me. I have already recognized the approaching voice as that of Sheena Tillman, a petite college junior with stick-straight posture and a focused gaze. She hands me a disposable paper mask through a break in the concrete, then a second one for my "sister." I lift the dummy gently from the dirt and snap the mask's elastic around its bald head. "We're gonna get you out, ma'am," Sgt. Tillman says, throwing down a small, pen-shaped chemical light.

Since Sept. 11, the reality has sunk in that these soldiers are more likely to respond to a natural catastrophe than a domestic terrorist attack.

Tillman has been in the reserves for five years. She hasn't been deployed. The tunnel, she'd told me earlier in the week, "is as close to real life as we can get so far." She keeps me talking as additional members of her platoon debate the best tool to break open my concrete cage. At first they seem intimidated by the task. "This is easily 3000 pounds," I hear one soldier say as he examines the concrete wall between us. Tillman jumps in to reassure me: "Ma'am, right now we're just assessing your situation. We're just looking for the fastest method to get you two out."

The soldiers decide to use a plasma torch to slice through a steel plate that abuts the concrete. There are groups of rescuers all around now, all struggling to extract one of the two dozen dummies hidden in the rubble. Even though many of the mannequins are decrepit, some with missing limbs, the soldiers have been instructed to assume they are alive. As the first spray of sparks bursts through the cracks in the wall, I shift away from the heat. It takes 15 minutes before the sheet of metal is pried back and the soldiers reach in, grab me under the arms, and pull me onto a waiting litter. Then they lift me up and carry me to safety. **PM**



GREAT VEHICLES NEVER DIE, THEY JUST KEEP GETTING FIXED. SAY HELLO TO THE MECHANICS WHO SHOW LOVE TO CARS THAT MANUFACTURERS HAVE LONG ABANDONED.

by Ezra Dyer • photographs by Mathieu Young • illustration by Tim Boelaars

I COULD TELL YOU THE LOCATION OF RANDY EMA'S DUESENBERG GARAGE, BUT then I'd have to . . . well, actually, I couldn't even really tell you where it is. I'm standing right outside, and I need to call Ema to verify I'm in the right place because there's no sign indicating that this nondescript Los Angeles industrial building houses the world's premier Duesenberg restoration shop. When you're working on cars that sell for millions of dollars, discretion is the order of the day.

Ema belongs to a rare sect of mechanical specialists whose passion is devoted to a single esoteric vehicle. Most mechanics are generalists, but a handful of gearheads catch a fever for a particular machine out on the fringe and cultivate their expertise and resources until they become The Guy for that car. Temples of automotive obsession exist all over the country, populated by diehards who stoke the fire for Lancias or Studebakers or Mercedes-Benz Pullman limos. Ema's shop is my embarkation point for a 1200-mile pilgrimage up the West Coast to meet some of these characters and learn exactly how one becomes a nationally recognized authority on Duesenbergs, or the DeLorean DMC-12, or a GMC motorhome produced for five years in the 1970s. Because that last one in particular seems like a career path your high school guidance counselor most certainly would have recommended against.

If you're going to visit artisans of quirky and anachronistic auto engineering, you need an appropriately contrarian vehicle, so I borrowed a 2011 Mazda RX-8 for the trip. Mazda will halt production of the RX-8 after this model year, making it the last car to use a rotary engine. So if you own one of these Mazdas in 2032, you'll need to know someone who speaks the language of rotors and ports instead of pistons and valves. You'll need The Guy. But before

Toby Peterson, owner of DeLorean Northwest, has a background in aviation engineering but has switched careers to work exclusively on the repair and maintenance of the iconic '80s sports car.



you can enlist the help of one of these automotive shamans, you'll need to find him.

THE DUESY DOCTOR

Stepping through Ema's door is like entering Santa's workshop—if Santa had a serious thing for high-end antique cars. In one room, a drafting table holds a blueprint for some extinct part that's about to be reconstituted by Ema's craftsmen. In an adjacent room, a Bugatti motor sits on the floor next to a display case filled with old toy cars. Once you get past the museum-quality distractions out front—hey, is that a set of Duesenberg headers just hanging on the wall?—you're into the real action: the garage. Ema takes a photo of each car he's restored, and a far corner of the garage is wallpapered with snapshots of projects past.

Duesenbergs belong to a rarified league of automobiles. Founded in Des Moines, Iowa, in 1913 by brothers Friedrich and August Duesenberg, the company that bore their name created hand-built luxury performance cars on and off for 24

years. If you're lucky enough to own a Duesenberg (fewer than 1200 were made), Ema is the last word.

"I'm a historian," Ema says as we make our way toward the back of the shop. "History is a passion for me and has been since I was a little kid. I like an original piece because it's only original once."

Ema's never felt an urge to put his own riff on what the factories wrought, but one corner of his garage houses a personal project that allows some leeway for creative interpretation. "This is my hot rod," Ema says. "It's a '22 Duesenberg, but prior to 1934 someone cut the chassis and put a '28 Chrysler body on it." Today, fusing a Duesenberg and a Chrysler would constitute aesthetic and financial madness, but the chronological distance of that strange decision gives the car its own interesting story. And for Ema, that connects it spiritually to other Duesenbergs—each car was a reflection of its owner. Each car has a story.

"Nothing has come up to the standards of a Duesenberg," Ema

says. "No two cars are the same. You have this wonderful high-performance chassis and the body of your choice. Even today, they're fast." Supercharged Duesenberg Model Js could hit 129 mph, making them the Bugatti Veyrons of their era and a high-water mark for the American car industry.

There are 378 Model Js still in existence and Ema has laid eyes on all but three. There's one Model A he hasn't seen and it's in Australia. Ema maintains a stash of original drawings, patterns, and blueprints, which he uses to create more than 1000 different parts to keep the world's Duesenbergs on the road. For all practical purposes, Randy Ema is Duesenberg, circa 2012.

While Ema's workshop could keep me entertained all day, I've got an appointment with another enthusiast almost 7 hours distant in San Francisco. The object of Jim Kanomata's expertise is certainly less exotic than a Duesy, but his affection for a very specific machine—the 1973 to 1978 GMC recreational vehicle—makes him a kindred spirit.

SHOP: RANDY EMA, INC. **LOCATION:** ORANGE, CALIF.
OBSESSION: DUESENBERGS

The Duesenberg Automobile & Motors Company produced some of the most luxurious cars of the early 20th century but couldn't survive the Great Depression. Randy Ema owns 28,000 of the company's original drawings, so he can produce brand-new parts for cars that are more than 75 years old.



The garage of Randy Ema (right) is like a museum filled with artifacts from a golden age of American autos—but it isn't without its oddities. On jacks (above) is a mongrel Duesenberg that someone saw fit to mate to a Chrysler body long ago.





So I bid farewell, fire up the RX-8, and merge onto I-5 north accompanied by the hard-edged, 9000-rpm song of America's last rotary.

My drive to San Francisco, confined to the highway, doesn't afford much opportunity to explore the talents of the Mazda's chassis. The rotary's compact size and light weight allow for sublimely lithe and balanced handling. So when I miss the final turn for Kanomata's garage, I switch off the stability control and indulge in a wide, arcing drift in the empty parking lot of the adjacent business, which happens to be the now-defunct Solyndra solar campus. Solyndra may have bet the wrong way on solar panels, but its empty parking lot is excellent for doughnuts.

Even in the world of recreational vehicles, the GMC motorhome is a seriously odd duck. It lacks the shiny nostalgia-futurism of classic Airstream trailers and never achieved the name-brand cachet of RVs from Winnebago. The GMC motorhome





SHOP: DELOREAN NORTHWEST **LOCATION:** BELLEVUE, WASH.
OBSESSION: DELOREAN DMC-12

Surprisingly, shop owner Toby Peterson is not as sick of *Back to the Future* jokes as you might think. He's even been known to work on flux capacitors.

will forever be a child of the 1970s, with an anachronistic style and mechanical logic all its own.

Kanomata was bitten by the GMC bug in 1980, when he bought his first motor coach. Over the next 15 years, he figures he covered 600,000 miles. "I had to sell it because it had so many miles," Kanomata says. His second RV reached 400,000 miles before the motor—a nonstock 540-cubic-inch twin-turbo inter-cooled Cadillac V-8—asked for a vacation of its own. With all that wheel time, you'd think that the GMC motor coach would hold no more surprises for Jim Kanomata. But when you're dealing with a machine that combines the attributes of an Oldsmobile Toronado with those of a small house, the intrigue never dies. "You think that when you've put a million miles on it, you've figured out all the things that can go wrong. Well, you always find something," he says.

Kanomata's ascension to GMC authority was not exactly pre-

ordained. "It wasn't my intent," he says. "I wasn't happy with the performance mine was giving me. I started tinkering with the gears and then started selling them. Pretty soon I got a reputation as the guy who took care of problems."

Kanomata estimates that there are 5000 to 8000 GMCs still on the road, enough to keep him busy without working on vehicles that he deems SOBs—Some Other Brand. SOBs, in Kanomata's estimation, are trucks with boxes bolted to the back. The GMC's appeal is rooted in the fact that it was built to its mission from the ground up, bucking RV convention in favor of front-wheel drive and tandem rear axles. Not that GM didn't leave some room for improvement.

"We believe in anything that'll make it operate a little bit better, like fuel injection or disc brakes," says Kanomata, whose background is in aerodynamic engineering. Kanomata relishes pushing the limits of RV performance, whether via a 600-horse Caddy V-8 or heavy-duty stabilizer bars. He was once pulled over in his motorhome for going 93 mph, and that was before he added the turbochargers. "My wife doesn't put china in the cabinets anymore," he says.

THE MAN OF STAINLESS STEEL

My next destination, DeLorean Motor Company Northwest, lies about 800 miles north of San Francisco, which gives me plenty of time to contemplate the RX-8. The car is a magnet for rotary fanatics. While gassing up in Dunsmuir, Calif., a guy on the opposite side of the pumps tells me that he once owned a 1984 RX-7. When I ask if he ever had to work on it, he replies, "No, that's why I loved it!" before adding the rather Zen pronouncement "It wasn't fast, but it was quick."

I think I know what he means. The RX-8 is a back-road scalpel rather than a drag-racing blunt instrument. It's the kind of car that encourages you to get off the highway and find a string of corners where you can drop down a gear and pitch that rear-wheel-drive chassis toward an apex or two. And that's what I do in northern Oregon, catching the attention of a freight-train conductor traversing a raised trestle above the road. He waves and I wave back with my right hand, which is off the wheel because I'm busy shifting. In the RX-8, you're always busy shifting.

The knock on the Wankel engine is that its novelty doesn't justify its drawbacks—mainly, its prodigious thirst for fuel (on the highway, I average a trucklike 19.3 mpg). The rotary was born from technical innovation, but at this point it's more a signifier of free thinking. Sort of like gullwing doors or stainless-steel body panels.

DeLorean Northwest, just outside Seattle, isn't evident from the street—I'm detecting a theme here—but when I find it, I'm struck that this could be what a working DeLorean dealership might have looked like before the original company went under in 1982. A garage packed with cars awaiting service is flanked by a showroom where a pair of DMC-12s (the only model the company ever produced) beckons potential buyers. Even the official DMC sign outside is from an original dealership. Fans of a certain movie franchise might be tempted to ask: When are we?

Toby Peterson didn't have a grand plan to build a business around his favorite vehicle. But once he bought a DeLorean, the car steadily began to play a larger role in his life. "My wife and I were looking for a sports car in the late '80s," he says. "We found a DeLorean that was a basket case. Well, I'm one of

those guys who goes to the pound and wants to save all the dogs, so of course I bought it."

At Boeing, Peterson was a principal structural engineer on the 747. Which put him in a good position to investigate the failure points of his new four-wheeled acquisition. When a trailing-arm bolt sheared, he put it under an electron microscope for a fatigue analysis. It turned out the bolts had a flaw, a type of corrosion pitting that would eventually lead to disaster. "I'm able to get the best fasteners that man can produce, so I began making improved trailing-arm bolts in 1999," Peterson says. He began solving not just his own DeLorean problems, but everyone else's too. In 2006 Peterson traded wings for gullwings, retiring from Boeing to open DeLorean Northwest.

John Z. DeLorean himself would applaud the chutzpah of a business built around a defunct company that never made many cars in the first place—about 9300 DMC-12s left the factory. But those cars have a high survival rate, thanks to their stainless-steel bodies and the publicity generated by the *Back to the Future* movie trilogy. When Peterson held his grand opening, 25 cars showed up. Ten stayed behind for work.

And once you've got your DeLorean running, you'll probably be

tempted to enhance its performance. "The Peugeot-Renault V-6 is like the small-block Chevy of Europe," Peterson says. "There are lots of performance parts available for it." One customer car is awaiting a supercharger, and when we step outside to fire it up, we find a mechanic from a shop next door eyeing the RX-8. It turns out that he's a former Mazda salesman who sold the first RX-8 in North America. "A guy came in six months before the car was available and put down a \$10,000 deposit," he says. Mazda says it's committed to continuing development of the rotary engine, but it's possible that the 2011 RX-8 is the Wankel's last chance to power a new car. As the years go by, mechanics devoted to the rotary will become a rare breed.

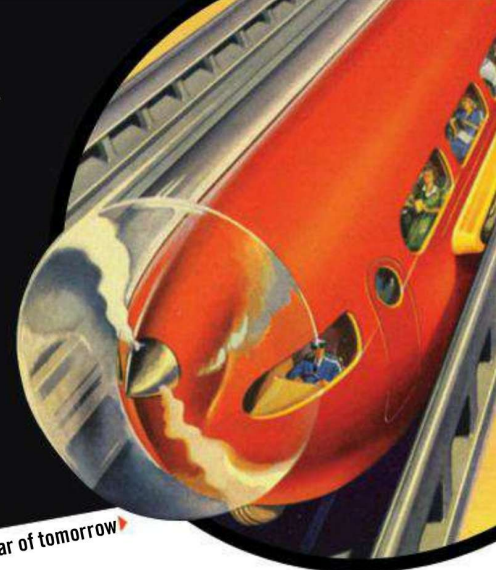
"I know a guy who races an old RX-7," the mechanic says. "Because the rotary is so compact, he rebuilds it on his kitchen table." Mazda's rotary might be far more prolific than the DeLorean DMC-12, the GMC motorhome, or the Duesenberg Model J, but it's similar in kind, an esoteric offshoot of automotive history that attracts a passionate following. That's a brand of devotion that Peterson, Kanomata, and Ema would probably understand. "I bought the car to save it," Peterson says. "And it ended up taking over my life." **PM**



The author visited shops that service defunct automobiles in a vehicle destined for defunction. The Mazda RX-8 is the last car to sport a rotary engine.

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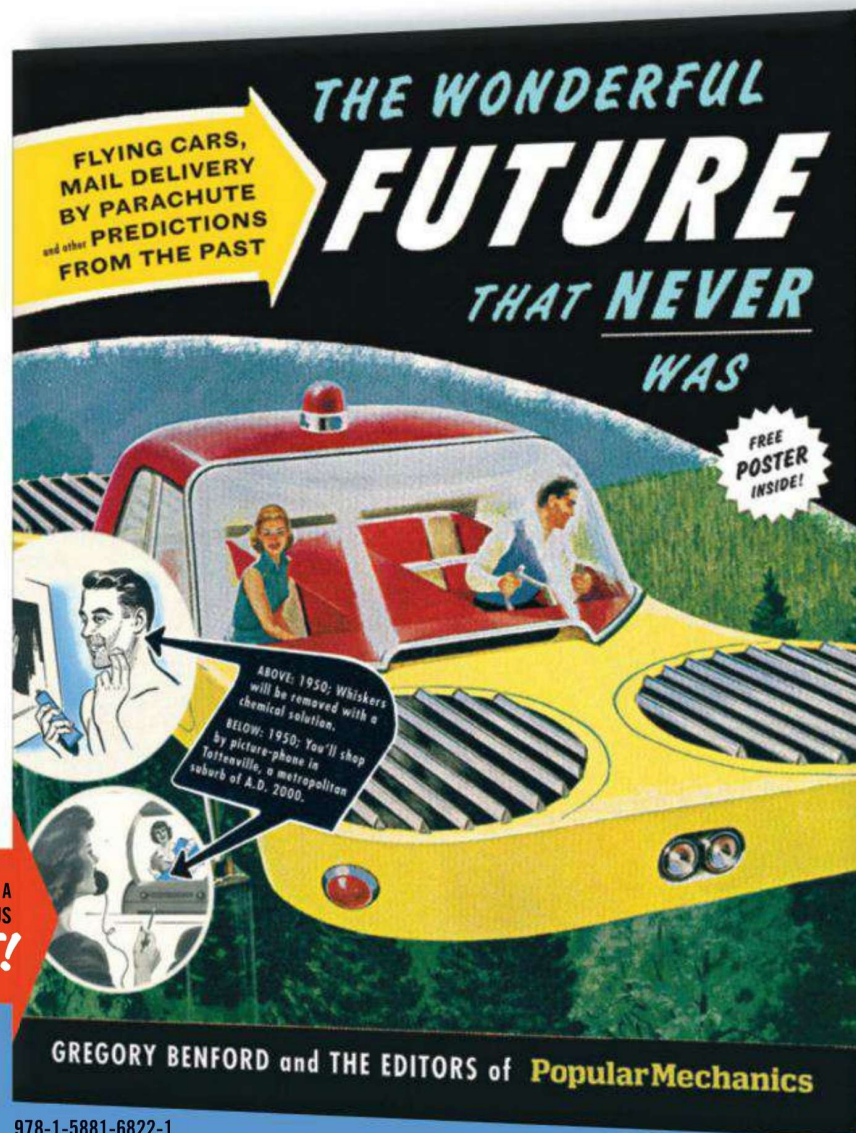
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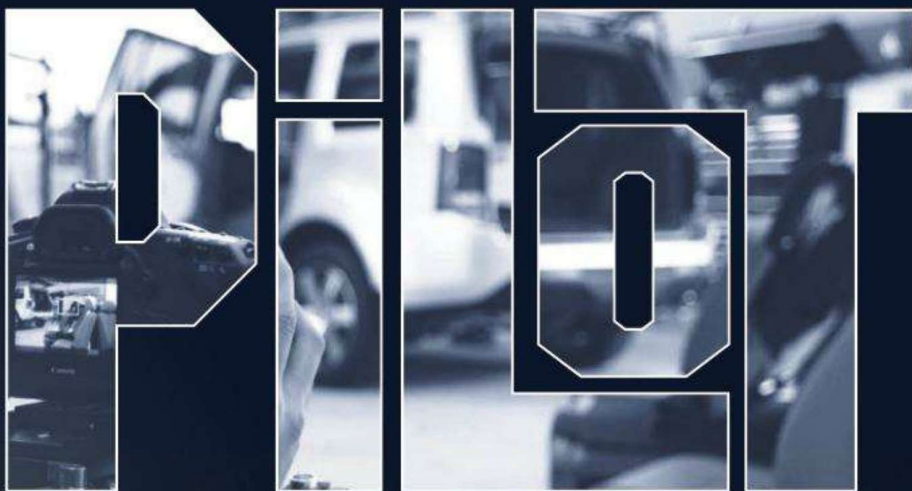
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THE RINGER



Our previous Top Shop make-over projects were East Coast creations. Netcong Auto Restorations and Creative Auto Interiors in New Jersey built our 2010 1SS Camaro, as well as the 2011 Pony Express Mustang. The Camaro concept: a muscled car with fully defined six-pack abs. Its Vortech-supercharged LS3 put out about 600 HP at the crankshaft.

The 2011 Mustang had more of a gold necklace/Adidas jogging suit attitude. While it certainly did go, Netcong Auto Restorations prioritized the ragtop's "show." The project also gave the company's owners, Dana and Phil Brazer, a chance to show off teenaged son Grant's design skills. A complementary Victory Hammer S V-Twin motorcycle was also created for the adventure portion of the project, a pairing so popular (part of our mantra), we're doing it again.

The 2012 Top Shop continues our tradition of working with an established, highly respected, family-owned business. Galpin Auto Sports' parent company, Galpin Motors, was founded in 1946. Current CEO Bert Boeckmann was hired as a salesman at Galpin Ford in 1953, the same year the first "Galpinized" vehicle—a 1952 Ford conver-

tible customized with Lincoln and Mercury parts—appeared on the cover of various automotive mags.

This year's project takes a sharp left turn from previous years', both geographically and philosophically. Instead of roasting rubber or trolling the Vegas strip in a drop-top, our theme is Left Coast active-family cruising. Styling and profiling are what it's all about on the West Coast, so we're creating an attention-attracting Pacific Coast Highway people-hauler.

Shooting the Pilot is our mission. We're making the automotive equivalent of a Spaghetti Western. Project HQ for Top Shop 2012 is Galpin Auto Sports (G.A.S.) in the wild, wild urban west: Los Angeles, the entertainment capital of the world.

No stranger to shooting pilots, the shop hosted MTV's *Pimp My Ride* from 2006-2009. Our Western shoot is also Italian-influenced. Its cast and crew are all-American, but our star's make-up and associated special effects are sequels to a production from Bolognese, Italy: We're shooting the Pilot with Lamborghini-inspired matte pearl paint.

Throughout, the Pilot is also being shot by VIMBY (Video In My Backyard). This company is a joint venture between Hearst Corporation and reality TV king Mark Burnett, the famous creator of *Survivor*,

Left: The Pilot's first shoot—a stock 2012 Alabaster Silver Metallic model is scrutinized by G.A.S. Director Ted Mengiste (left), Rendering Artist Doug Breuninger (top) and G.M. Steve McCord (right).

Top: Ted Mengiste, Mad Mike and Steve McCord plot the underhood upgrades, including dual Interstate batteries to power the A/V system and a K&N air filter.

Bottom: Like most studios where pilots are shot, G.A.S.'s backlot is hidden from public view.

D.Y.K.

DID YOU KNOW? The Spaghetti Western genre was named for its Italian creators. Director Sergio Leone spoke to (and often down to) his actors, including Clint Eastwood, through translators. The "spaghetti" in our western-based build-up by a company adept at creating TV and movie vehicles is a Lamborghini-inspired matte-metallic paint job.



Sergio Leone
(1929-1989)
defined the style of the Spaghetti Western.



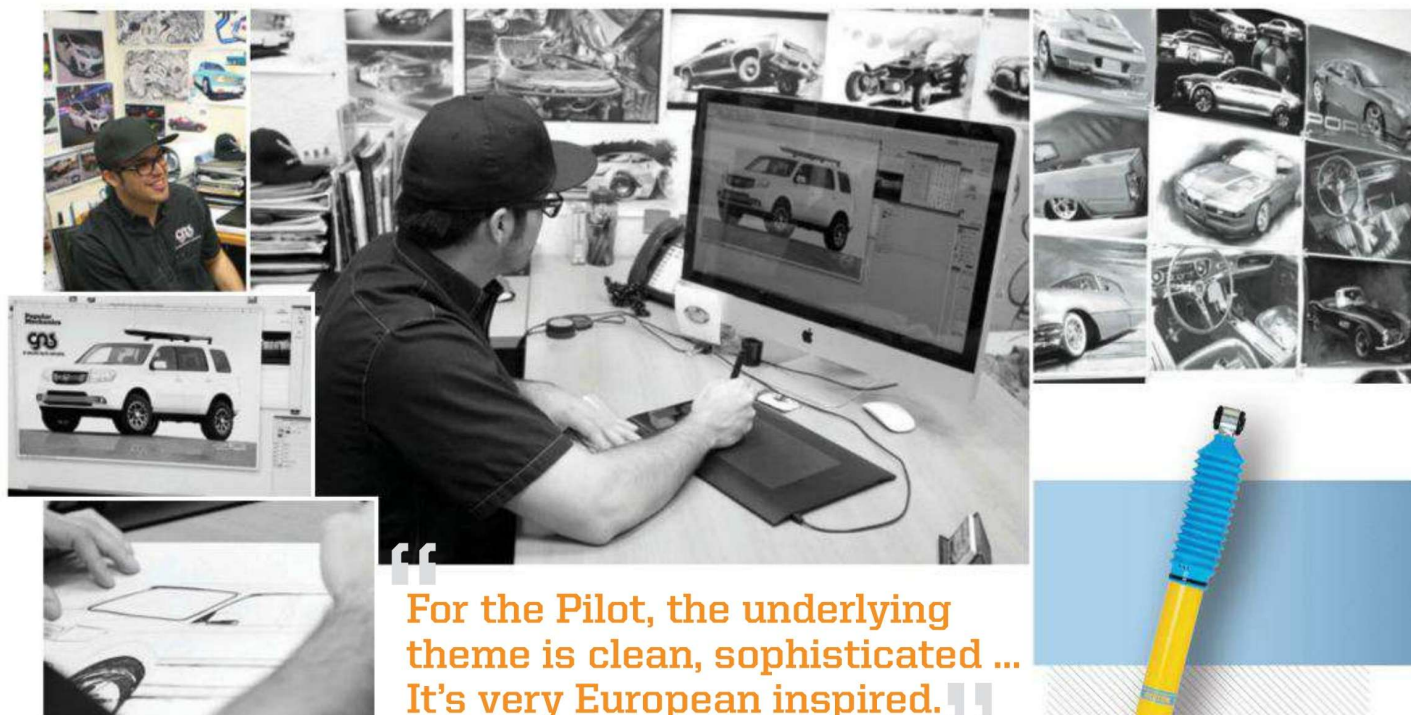
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“For the Pilot, the underlying theme is clean, sophisticated ... It's very European inspired.”

— DOUG BREUNINGER

The Apprentice, *The Voice*, and *Are You Smarter Than a 5th Grader*? This project will culminate in a Part 2 photo and video shoot at historic Hearst Ranch on the Central California coast. We have our agenda ready. Now we just need proper transportation for our weekend getaway.

THE SHOOTING SCHEDULE

As with most TV and movie shoots, time isn't on our side. Popular Mechanics has a set-in-stone newsstand on-sale date, and pages are reserved for this build-up.

Fortunately, the *Pimp My Ride* experience exposed G.A.S. to worst-case scenarios. “Having the TV show got us used to deadlines and delivering on time,” GM Steve McCord says. “The guys pulled a few all-nighters to make sure everything was done and working for the film crew.” Luckily, we have Blackfire Clamplights to help our tired eyes focus on late-night thrash tasks. These lights' bright LED bulbs can be aimed for pinpoint accuracy, thanks to a handle that functions as a clamp and also as a stand.

If anything, G.A.S.'s TV and web notoriety makes them dig deeper, not ego-trip.

“You say ‘Galpin’ and people have a certain expectation,” McCord says. “We work hard to develop that.”

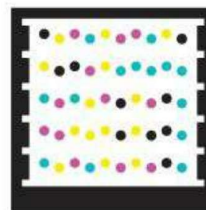
Also working against our four-week timeline: Few over-the-counter aftermarket accessories are available for the Pilot. Mats, cargo organizers and a few other bits are sold through Honda dealers and on eCommerce sites such as RockAuto.com (replacement headlights, bulbs, a hitch, to name a few), but the pickin's are otherwise slim. So, G.A.S. chose to fabricate distinctive details. Custom work takes time, something we aren't flush with. For example, Borla offered to make a stainless-steel dual exhaust system. Since the Top Shop Pilot couldn't be out of circulation for Borla's weeklong R&D, many phone calls were made to locate a loaner guinea pig.

Coordinating other vendors can be a greased-pig chase. ICE (in-car entertainment) components are easy enough to procure. However, lifting a vehicle that normally stays at stock stance is a head-scratcher. Galpin Honda took the initiative and R&D'd a mild lift/leveling kit with ReadyLift. This bolt-on system uses billet 2-inch-thick front spacers and steel rear 1-inch strut extensio-

MONOTUBULAR RIDE-IMPROVERS

Bilstein revolutionized the ride-control industry in 1957 by introducing the monotube gas-pressurized shock absorber. Compared to twin-tube technology, the monotube design allows a significantly larger piston surface. Greater sensitivity to road conditions for better control is a main benefit, as is improved heat-dissipation for consistent performance. Bilstein shocks and struts are OE on many higher-end vehicles. They're offered as aftermarket upgrades for most others.

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D.Y.K.

DID YOU KNOW? The producer is responsible for compiling the show's pieces. This includes procuring the script, finding funding, setting budgets and hiring key talent. The director translates the script's words into moving pictures. In Hollywood terms, Popular Mechanics is this project's producer; G.A.S. GM Steve McCord is its director.



Steve McCord
GM

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Head Strap Mount



Suction Cup
Mount



Handlebar Seatpost
Mount



Vented Helmet
Strap



Top: Bilstein shocks and struts for Pilots didn't exist when this project began.

Below: Firestone's Ride-Rite Coil-Rite kit easily installs in the rear coils. It's the supporting cast for our hitch-mounted Honda motorcycle.



ns to accommodate up to 31-inch-tall tires. Bilstein offered its ride-control expertise to help compensate for the higher center of gravity and 500-pound motorcycle that'll dangle from the rear receiver hitch. The company doesn't have off-the-shelf coilovers or struts for a lifted Pilot (or even a stock one), but they'll develop an upgraded damping system for us at some point in the near future.

Other beltline-down line items were labeled TBD as the Pilot entered the paint booth—and this article's deadline expired. These include upgraded brakes.

THE BACKSTORY

This project began with phone conversations and sketches. Using a Pilot presents a "pimping" paradigm shift. G.A.S. is used to creating show-stopping concept vehicles: mobile recording studios, tattoo parlors on wheels. Its wide-body Mustang conversions are popular, adding nine inches of sheetmetal girth for surer-footed ponycars.

Although the sky wasn't the limit here, building a Pacific Coast Pilot was still challenging. We're targeting active families, parents aged 35-45 who make decent livings and who might've cut their automotive teeth on furiously fast sport-compacts such as the Civic. As they spawned, these parents' were better filled by comfortable crossover SUVs, aka CUVs. These people's passions for performance and personalization often remain, however. (Hopefully their affinity for coffee-can mufflers has faded.) Also, primary Pilot drivers are split evenly between male and female, according to Galpin's Honda dealership. So, our weekend-getaway Pilot should appeal equally among genders.

Galpin Auto Sports considered all possible iterations of a California coastal-cruiser. Should it be lifted and ride on knobby 35-inch-tall tires for maximum ground clearance and off-pavement traction? Quick research revealed that Honda Performance Development already did this with its Desert Pilot, a race vehicle that finished

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third in its class at the 2011 Baja 1000—and had virtually no factory Pilot parts.

G.A.S. rendering artist Doug Breuninger explored the other extreme: slamming the SUV California street-truck style. “I love the trucking scene because those guys radically push ideas,” Breuninger says. “Going as blue sky as possible, I would cut out sections of the roof. I would also shorten the vehicle and give it a California custom street flavor. That would give it a ridiculous proportion to catch your attention.”

Breuninger sketched his concept: the Pilot he’d like to own. “I start out as wild as possible because you can always pull back,” he volunteers. “It’s better to have more than you expect than not enough.”

As the G.A.S. team brought the Pilot project into focus, they defined their ultimate aesthetic goal: transforming a conservatively designed vehicle into something that looks even more expensive. “That’s a nice challenge to have,” Breuninger says.

CASTING (PARTS ASIDE)

Almost like a Tijuana chop shop, G.A.S. had the interior out of the Pilot in mere minutes as VIMBY’s cameras rolled. J.D. Hendrickson’s wardrobe included new Mechanix Wear M-Pact gloves as he ratcheted out bolts and pulled interior panels—and even removed the Pilot’s esteemed third-row seat to make way for mobile entertainment upgrades.

Unsolicited, Hendrickson elaborated on this product placement: “Mechanix is all I wear. I’ve used upwards of ten different Mechanix Wear styles.” He appreciates the M-Pact’s extra padding, particularly around the knuckles: “It has a lot more protection if your hand falls off the wrench.” This style also adroitly traps fiberglass shards.

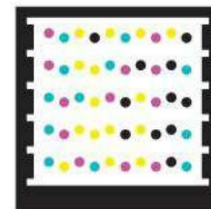
Next, G.A.S. upholstery specialist Javier Perez laid fabric swatches on the front and back seats. Perez has done custom auto upholstery since 1977; his job is increasingly more challenging as safety restraints evolve. McCord elaborates: “Some interior



TRAVELING SPIELBERG

In the early days of cable TV, electronics store owners portrayed themselves as crazy, offering insanely low prices. The modern equivalent: GoPro HD action cameras. The new GoPro HD Hero2 adds Medium (127°) and Narrow (90°) Fields of View to the existing Wide (170°) offering. Still images up to 11MP are now possible, and an external mic port is also standard. Base MSRP is only \$299.99.

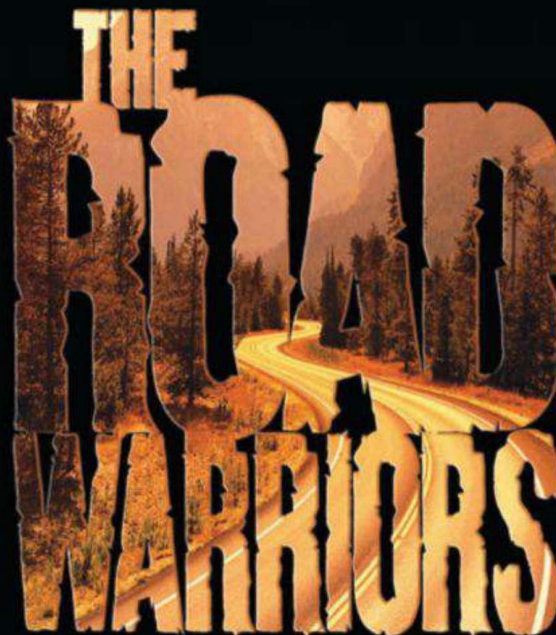
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Javier Perez re-bolstered then reupholstered the Honda seats in two-tone leather.

The process began by sketching possible patterns in chalk on the factory fabric.



customizers don't take into account the side airbag curtains and other modern safety equipment. We have to make sure that everything we do is compatible with those systems."

Like an accomplished residential interior designer, Perez knows how to make existing platforms more luxurious. Step one: a contrasting two-tone upholstery theme. For a high-end look and feel, Perez chose OE-grade, ISO 9001-spec black "barracuda" perforated leather for the contrasting center inserts. This lets the seats breathe and allows the front under-bun heaters to transfer more warmth.

After denuding the stock seats, Perez added firm foam bolsters to the front buckets. This gives the Pilot's thrones more of a sportscar feel. "You won't slide around while you're going through the canyons," McCord says. Perez color-matched the bolster leather to the Pilot's gray plastic seat adjuster panel as a subtle attention to detail.

Once the two-tone pattern was cut, Perez showed some stitching mastery. French double-stitched seams are common in higher-end vehicles, so the technique was used here. Demonstrating even more attention to detail, Perez used contrasting thread colors to highlight the high-grade skins on

the stock seats, front and rear.

Before the leather was wrapped over the cushions, G.A.S. pulled the unexpected. Embroidered and silkscreened upholstery logos are popular—and been-there/done-that. As an alternative, G.A.S. dials down the power on its CAD/CAM laser-cutter. This effectively cuts only the top layer of the material, basically burning a brand into the leather. It's another subtle touch that makes this Pilot unique.

These cues go throughout the interior. The vinyl headliner mimics the black seat inserts, the plastic pillars are also covered in vinyl while the the console is also leather-bound.

To tie the steering wheel into the rest of the cabin, G.A.S. used Grant Products' Revolution program. This approach customizes an original-equipment steering wheel while retaining the stock airbag. Grant's menu offers wood veneer and hydrodipped film patterns such as carbon fiber. G.A.S. supplied Grant with the same materials used for the upholstery for custom leather-wrapping, complete with matching stitching.

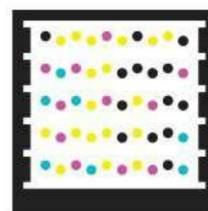
THE GAFFERS

While the sewing machines whirled, Mad Mike and Hendrickson engineered the

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D.Y.K.

DID YOU KNOW? In Hollywood, the Art Director helps evoke a project's moods visually. Sketches are the starting point for creating the appropriate ambiance. G.A.S. rendering artist Doug Breuninger began our project similarly. The G.A.S. team collectively worked as set designers and propmasters, deciding which colors and aftermarket products best fit the theme



Doug Breuninger
Render Artist



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PROGRESSIVE



Just fire the subs backwards, so they load off the back wall.

— J.D. HENDRICKSON

electronics. "This one's pretty simple," says Mad Mike, a former Air Force radar operator with 25 years' auto-customizing experience. "We're doing three digital amplifiers and a processor amplifier because we're leaving the factory radio. We'll have two separate systems: one for the vehicle itself and another one for the tailgate party."

The G.A.S. guys admit that the top-of-the-line Honda factory onboard electronics don't leave much room for improvement. The Pilot Touring package includes a 650-Watt AM/FM/CD 10-speaker audio system, subwoofer included. A voice-activated nav system is integrated with the sound system, satellite radio, and multi-angle backup camera. It's also Bluetooth-compatible and iPod-ready. A flip-down DVD monitor provides backseat entertainment.

Hendrickson began by building a custom subwoofer box from medium-density fiberboard. He says it's something the home enthusiast can easily do. Hendrickson recommends MDF because it's denser than plywood or particle board. Because the sound here is ultimately for a hatch-up tailgate

party, Hendrickson says speaker placement isn't critical. His generic DIY tip: "Just fire the subs backwards, so they load off the back wall." In civilian terms, that means to make sure that the subwoofers are rear-facing.

Although our audio upgrades definitely add the dBs, the components were selected primarily for their clarity and mounting flexibility. For example, compact Kicker IX series amplifiers use non-linear Class D technology (where switches are either fully on or fully off) to reduce power losses in the output devices. This yields less amperage draw from the charging system and radiates only warm-to-the-touch heat during extended use.

Kicker IX1000.1 1,000-continuous-watt mono amps were chosen to power each Kicker S10L7 subwoofer. These 10-inch square subs were selected because they have 20 percent more cone area than similar-sized round subwoofers. They can be mounted in either sealed or vented boxes, giving Hendrickson further flexibility.

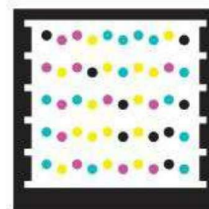
The rest of the system: a Kicker IX500.4 four-channel (75 max watts per) amp to



KICKIN' OUT THE JAMS

Deep bass is one area where many OEM sound systems are deficient. Enter Kicker. Its Solo-Baric L7 Subwoofer has a patented square design, moving more air than similar-sized round cones. The S10L7 model we're using handles 1,200 watts of peak power. It's powered by Kicker IX Series amps, chosen for their small footprints and Fail-Safe Integration Technology that rejects noise and interference from other onboard electronics.

kicker.com



To check out the highlights of Kicker's new offerings, scan here

D.Y.K.

DID YOU KNOW? A show's head electrician, whose primary responsibility is lighting, is known as a gaffer. The term is from the 1930s, when overhead lighting was adjusted using gaff poles. If this project had a gaffer, it'd be Mad Mike. The gaffer's assistant is known as the "best boy."



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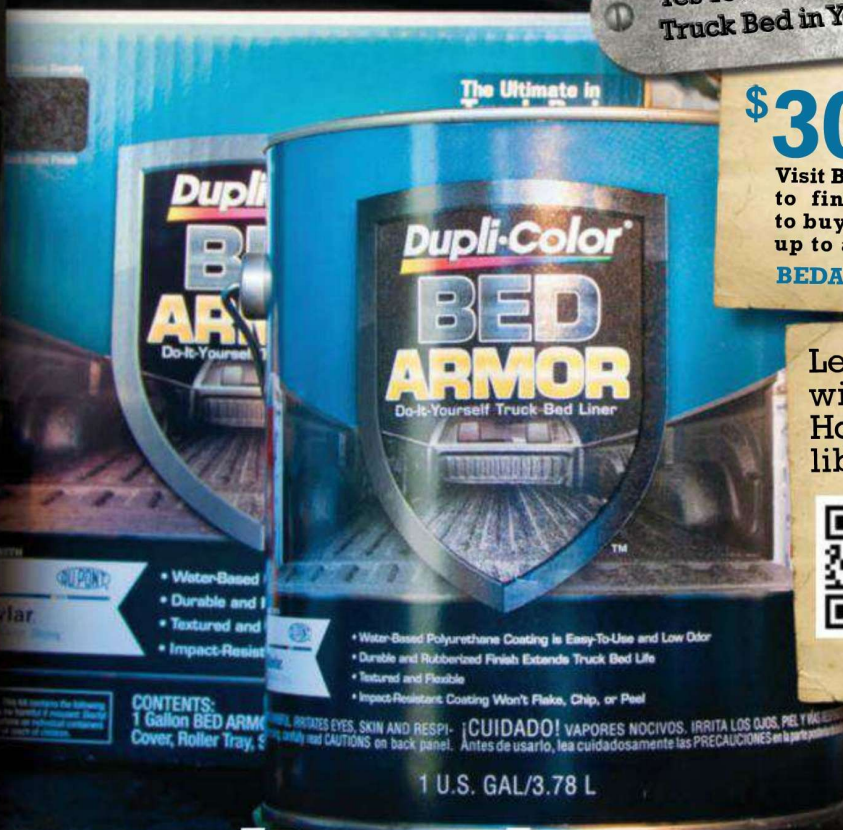
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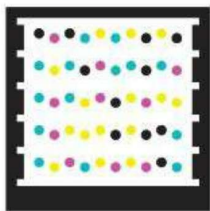




DUPLI-COLOR OUR WORLD

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feed a pair of door-mounted RS65.2 6.5-inch 2-way speakers and two RS60.2 6-inch speakers.

Mad Mike wired the Kicker components into the factory sound system. The two exceptions: Stand-alone 6-inch speakers will be dedicated to the cargo area's video monitor. Hendrickson decided to conceal these speakers under a custom fiberglass panel. He cribbed the Pilot's dashboard contour for his panel, a subtle reference that might go unnoticed if Hendrickson hadn't mentioned it. Because these speakers will likely be heard only when the liftgate is up (i.e., over ambient noise), Hendrickson opted to conceal them instead of striving for optimal acoustics.

To complete the rear-facing cargo-area entertainment system, aka tailgate party, G.A.S. installed an Audiovox VOD129 12.1-inch flip-down LCD monitor. The unit has its own DVD player and also includes a domelight and wireless headphones. Then G.A.S. took it a step further. Invision front-row headrest monitors with 7-inch displays and individual DVD players were added. These OE-grade headrests meet crash-test standards, unlike some lower price-point brands. G.A.S. received them bare so Perez could upholster the headrests to match the seats. Mad Mike then wired the displays so that all could play from the same source, thanks to RF transmissions to the Pilot's audio system.

A conceptual priority here is active participation as opposed to a passive entertain-me attitude. With this in mind, Mad Mike and Hendrickson also brainstormed mounts for multiple GoPro Hero HD2 action cameras. Compared to the industry-rocking original GoPro, the second-gen camera adds two different field-of-views (FOVs) to the original's fish-eye perspective. This could revolutionize family-vacation home movies.

The GoPro HD2 also has seven possible time-lapse settings, snapping an image every 0.5, 1, 2, 5, 10, 30, or 60 seconds. VIMBY filmmakers Ed Wu and Eric Thompson used this feature to document part of the Pilot's build-up.



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Mad Mike also added an Escort Passport 9500ci radar/laser detector to the dash. Our Pilot's off-the-lot ride is so mannerly that we don't always realize how fast we're actually going. The discreet Passport 9500ci display provides accurate reminders to check the speed prior to entering law enforcement's crosshairs. Software features include proprietary Traffic Sensor Rejection (intended to eliminate false alerts) and a three-year subscription to Escort's Defender Database of safety-camera locations throughout North America. Hopefully that database will dwindle...

MAKE-UP, SPECIAL EFFECTS

To the pros, a custom paintjob exudes the vehicle's personality as much as or more than its aftermarket accessories. Flat is currently where it's at. Who knew that rat-rodders who couldn't afford top coats would inspire today's high-end look? Lamborghini's factory Bianco Canopus matte pearl white color on the current Gallardo and Mercielgo is G.A.S.'s inspiration for elevating this Pilot's social status. They want our SUV to look like it has a custom \$20K paint job.

Under normal circumstances, G.A.S. spends three to four weeks executing a Pebble Beach-quality paintjob. The vehicle is almost totally disassembled: windows, weatherstripping, doors, hood, trim piece, tailgate and more are removed so that all obvious traces of the undercolor can be covered.

G.A.S.'s go-to painters at Ford Auto Body normally shoot urethane paint. It's durable, lasting up to 20 years on garaged vehicles. Urethane is intended for professional use: California law requires it to be applied only in an approved paint booth.

For this job, Dupli-Color volunteered its DIY-targeted Paint Shop Finishing System acrylic lacquer. Unlike previous-generation formulations, Paint Shop lacquer has low enough VOCs that it can be sprayed at home in a makeshift garage paint booth. Read that again if you must, Californians.



Top: Replacing audio fuses with the help of Blackfire.

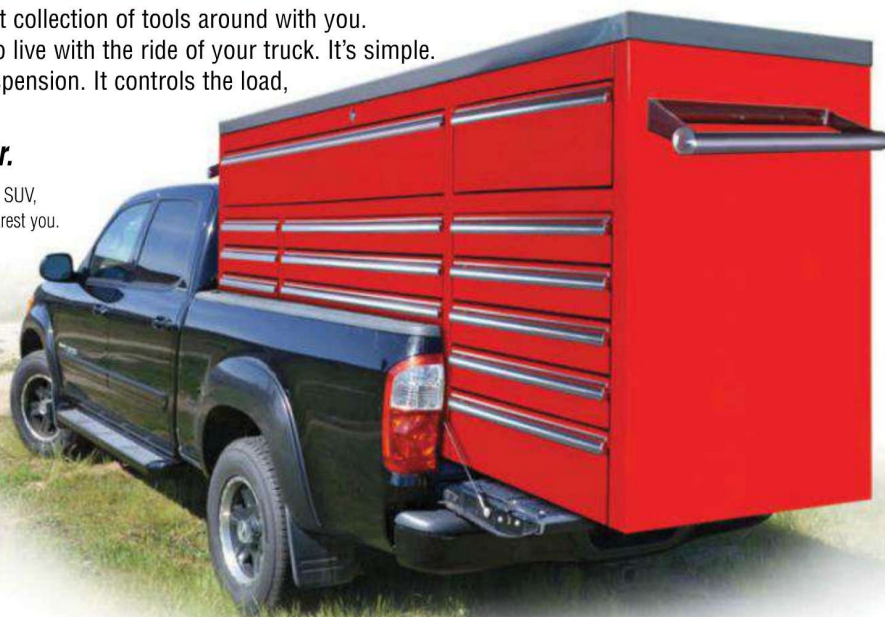
Bottom: Installing a rear-facing flip-down monitor gives the Pilot spontaneous tailgating potential.

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The body was prepped with 800-grit sanding and passes with the gray and red Scotchbrite pads. This gives proper paint adhesion; sealer wasn't necessary here over the factory paint.

For the color coats, we're using Dupli-Color's Championship White and Mineral Gray, two of the 11 available Paint Shop Finish System hues. (The Dupli-Color website also has user-submitted recipes for mixing custom colors.)

An optional mid-coat can be laid on if special effects are desired. The two Dupli-Color Paint Shop choices are Metallic Clear and Prism Clear. G.A.S. chose the Metallic Clear to best emulate late-model Lambos' shimmers. Finally, the Paint Shop top clear coat is available in matte and clear. Clear needs color-sanding to shine; matte obviously doesn't.

Painter Danny Quezada began with a "spray-out" on a test panel. He tried different California-compliant, gravity-feed HVLP guns for both solvent and water-based paints, preferring the former for ma-

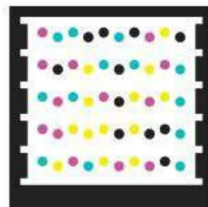
ximum metallic particle transfer. Quezada varied the gun distances and experimented with "fogging" techniques to get the mid-coat's suspended metal particles to best refract sunlight underneath the "dazzle-subduing" matte topcoat. The goal: a final sheen similar to an actual pearl's.

This Dupli-Color Paint Shop lacquer flashes in as little as five minutes. Quezada's main challenge was keeping a wet edge as he quickly laid down three coats each of the color, metallic, and matte clear. One fast-drying benefit: Any imperfections to the wet paint can be sanded out with 600-grit paper. Touch-ups can be applied shortly thereafter. Finally, the Paint Shop colors are ready to shoot from the can—no thinning required. Dupli-Color doesn't recommend straining the mid-coat materials. However, Quezada discovered that the particles can clump in gravity-feed HVLP guns. He used a medium-mesh straining filter, which captured some of the larger metallic particles. Quezada says clumping likely wouldn't be a concern in a traditional bottom-jar paint gun.

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D.Y.K.

DID YOU KNOW? Today's gazillion-dollar cosmetics industry was realistically launched by Hollywood makeup artist Max Factor in the early 1900s. Just as Factor's makeup make-up changed when movies evolved from B/W to color, automotive paint has progressed from 1890's India enamels to acrylic lacquers to today's waterborne base/clears. Our Dupli-Color acrylic enamel's heritage is in the 1940s. However, better living through modern chemistry makes the Paint Shop's environmental impact minimal.



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Left: Mad Mike and J.D. Hendrickson wire up the ICE.

Right: A custom grille with backlit logo should make even non-enthusiasts aware that this Pilot isn't available on Honda dealers' lots. Euro/no-chrome touches include body-color trim pieces and even a color-matched Yakima Sky Box cargo pod. Phillips HID headlights and LED blinkers complete the front end.



A monochrome mentality increases the upscale Euro élan: The factory chromed grille surround and tailgate trim panel were shot body color. Because G.A.S. stripped off the door side moldings prior to painting, they chose to replace the Touring trim level's chrome-accented moldings with solid ones from the lower trim levels. Otherwise, hairline seams from the chromed strips would show under the Dupli-Color white. G.A.S. is affiliated with a Honda dealership, but readers who are doing this at home might price-shop OE body parts online

at such sites as RockAuto.com before frequenting their local dealership.

Rocker panel cladding, the front fascia and the new grille insert were shot Mineral Gray for contrast. G.A.S.'s goal: creating an assembly-line quality paintjob that enthusiasts would rapidly realize wasn't on the factory color palette. To protect the Pilot's paint during its victory tour, Turtle Wax ICE Liquid polish will be on-board. We're holding a casting call for production assistants to apply the Turtle Wax.

While the Pilot was at the paint shop,

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The Honda NC700x body parts ready for paint.

Hendrickson fabricated a custom grille. The stock plastic three-bar grille and logo gave way to a water-jet-cut frosted-acrylic band with integrated Honda logo. "Wow factor" comes from backlighting the grille with a strip of oracle LEDs. Mad Mike wired the grille to the daytime running lights so it'll always be illuminated. Hendrickson and Mad Mike had so much fun creating the grille that they fabricated complementary LED-backlit door-sill panels.

STUNT BIKE?

Adding a Honda motorcycle is the cherry atop this project. Last year's car-bike combo, a suggestion that actually came from Progressive Insurance, was a hit with Pop Mech readers. The bike also helped sell Galpin on the Top Shop 2012 project—it and the fact that the company owns a Honda car dealership.

The Honda NC700X shares the same weekday-worker/weekend-player attitude as our project Pilot. This "adventure bike" hadn't officially been introduced in the U.S. at press time. NC700Xs are carving up Europe, but only one unit was stateside when Galpin tore into the Pilot. Honda delivered a spare set of plastic body pieces, decals and an extra seat so the bike's paint and upholstery could be matched to the SUV.

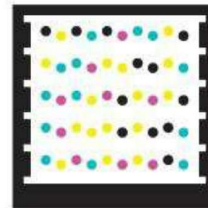
Adding 500-plus pounds to the Pilot's posterior created some challenges. First, G.A.S. reinforced the Honda hitch for



GPS SPEED WARNINGS

Escort takes radar and laser defense to intergalactic levels. Its new 9500ci uses GPS to discern between real and false radar-gun signals in less than a second. Further, "shifting" laser technology makes those speed-of-light tickets, even from double-pulse guns, a thing of the past. The 9500ci also comes with an updatable Defender Database of known red-light cameras. Best of all, the 9500ci is undetectable to detector detectors.

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G-OIL® Makes NASCAR History; Malsam Takes Sixth at Daytona COPD 300

Taylor Malsam, the #19 G-Oil Toyota Camry and TriStar Motorsports teamed up to make NASCAR history at the DRIVE4COPD 300, the opening race of the 2012 NASCAR Nationwide Series. The event marked the first time that bio-based engine oil has been used in NASCAR competition. The G-Oil - TriStar-Toyota teams combined to be the top Toyota in qualifying and lead laps (#44 Mike Bliss) and be the top finishing Toyota with Malsam's sixth place in the 300 mile, 120-lap event.

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~ Mark Smith, PME & TriStar Motorsports owner



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Checking out the Grant steering wheels at G.A.S.



structural soundness under the motorcycle and rack's weight. So the Pilot wouldn't always be driving uphill with the bike on the back, G.A.S. added Firestone Industrial Coil-Rite air springs. The kit's polyurethane bags install easily inside the rear coil springs—no drilling required. The system's optional

Air-Rite kit adds an air compressor, a gauge, bleeder valves and switches so air pressure can be controlled from the driver's seat. At max inflation, the Coil-Rite air bags have a 1,000-pound load capacity, more than enough for our 472-pound NC700X.

Speaking of the motorcycle, European riders give the NC700X rave reviews. Honda gets pats on its back for the bike's clean design lines and overall quality. Handling is touted as best in class. It fits perfectly with the California adventure theme. We'll ride confidently, knowing that Progressive Insurance is behind our coastal cruises.

Our active Pilot family could conceivably take everything to the beach. As the kids put on their wetsuits and get their boards out of the Yakima Skybox, dad (and/or mom) could unload the NC700X and do some canyon-carving while the rest of the family is immersed in sand and saltwater. Then GoPro movies of both the bike and beach adventures could be played on the rear-facing Audiovox monitor and InVision headrest monitors while the family re-loads. That's recreating right.

ALMOST A WRAP

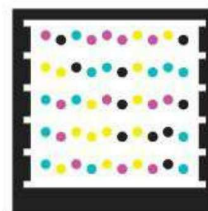
Final Pilot details were being firmed up at this installment's deadline. In Part 2, we'll tie up the loose ends or, more literally, crimp on the connectors. The Pilot's suspension, tires, wheels, exhaust and brakes were being finalized as our editorial deadline loomed. Also, we'll somehow get the painted body pieces and reupholstered seat on the lone Honda NC700X in the U.S.

We have the VIMBY film crew reserved and our itinerary set. Our couple is set to pick up it's galpinized Pilot. The Pacific Coast Pilot is almost ready for its close-up at the Hearst Ranch. Stay tuned to see the finished product.

SPECIALIZED INSURANCE

Does your homeowner's insurance agent ride? If not, an insurance company that specializes in home and life might not understand what it means to be in the wind. Progressive Insurance does. The company has provided motorcycle and dirt-bike policies for more than 35 years. Progressive insures more riders than anyone. When it comes to motorcycle insurance, go with Flo.

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D.Y.K.

DID YOU KNOW? A show's climax is its highest point of dramatic tension. Tune in next month for our thrilling climax. Will the protagonist Pilot and NC700X co-star get heckled by crusty east-coast tourists, sink in the sand and be washed out to sea or conquer coastal California? (We don't know yet, either.)



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DIY

Home

Playing Outside

THIS CLASSIC SWING SET WILL GO UP IN A WEEKEND—AND PROVIDE YEARS OF FAMILY FUN.

BY JOSEPH TRUINI

➡ **You can hire a contractor to build** an outdoor play set on your property, or you can try to figure out the project from scratch—but we don't recommend either approach. The first is expensive. The second is risky: Do you know what constitutes hardware that's strong enough to support a swinging child? That's where this project comes in. It combines hardware that comes as a kit from a reputable company with lumber you source and cut yourself. We used the three-swing Pathfinder hardware package and wave slide from Backyard City (backyardcity.com; about \$600), which had everything we needed for two swings, a trapeze bar, a sandbox, a 10-foot wave slide, and a ladder up to a canopy fort. The kit also includes detailed construction plans, bolts, screws, and

INSIDE

✕

DODGING FLOOR DAMAGE + BAD BATH FANS + WELDER 101

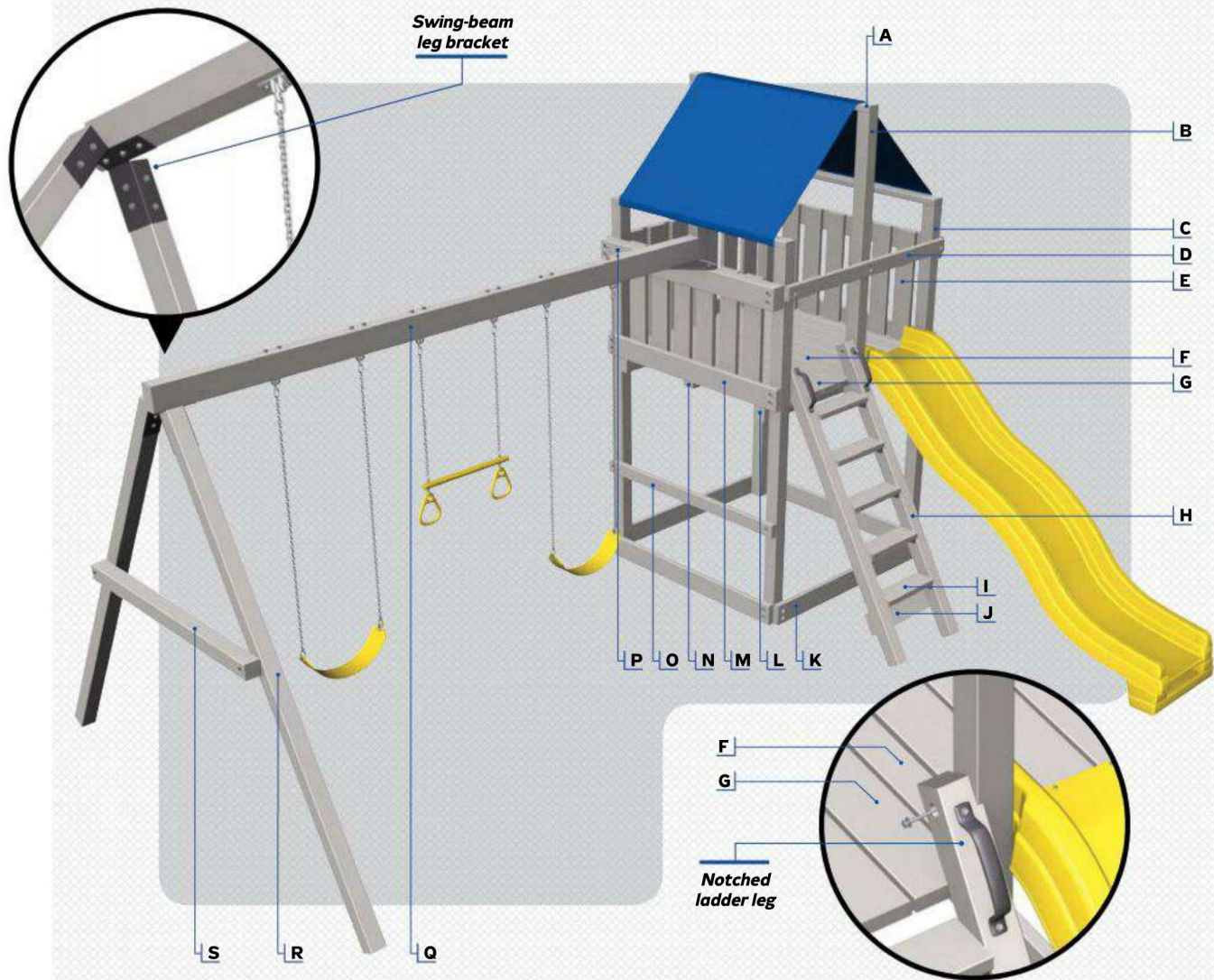
DIY **Home** OUTDOOR PLAY SET

Shopping List

Pressure-treated lumber

No.	Size	No.	Size	No.	Size
7	4 x 4 x 8 ft	8	2 x 6 x 10 ft	1	4 x 6 x 12 ft
2	4 x 4 x 10 ft	10	2 x 6 x 12 ft	3	1 x 4 x 8 ft
2	4 x 4 x 12 ft	6	5/4 x 6 x 8 ft		
5	2 x 4 x 10 ft	1	4 x 6 x 8 ft		

Play sand
Bark mulch
1 5/8-inch decking screws



Part No. Size and description

Materials List

A	3	2 x 4 x 58 in. (tarp board)	H	2	4 x 4 x 76 in. (ladder leg)	O	1	2 x 4 x 58 in. (safety board)
B	2	4 x 4 x 69 in. (center post)	I	5	2 x 6 x 17 in. (ladder step)	P	1	4 x 6 x 58 in. (swing-beam support)
C	4	4 x 4 x 96 in. (corner post)	J	1	2 x 4 x 23 1/2 in. (ladder brace)	Q	1	4 x 6 x 144 in. (swing beam)
D	1	2 x 4 x 58 in. (front panel board)	K	4	2 x 6 x 58 in. (sandbox board)	R	2	4 x 4 x 108 in. (swing-beam leg)
E	18	5/4 x 6 x 29 in. (wall panel)	L	2	4 x 4 x 61 in. (deck support)	S	1	4 x 4 x 58 in. (swing-beam crossmember)
F	3	2 x 4 x 51 in. (deck spacer)	M	5	2 x 6 x 58 in. (panel board)			
G	8	2 x 6 x 58 in. (deck board)	N	1	2 x 4 x 61 in. (deck stringer)			



She will always be your pride and joy...

My Daughter Forever

DOZEN RUBIES PENDANT

A beautifully crafted sterling silver-plated heart pendant ablaze with 12 rubies and over 30 simulated diamonds.

From the day she was born, she has been your treasure. Now, show your daughter just how dear she is to you with this breathtaking heart-shaped pendant, engraved on the back with: "My little girl yesterday, my friend today, my daughter forever."

Exquisitely crafted.

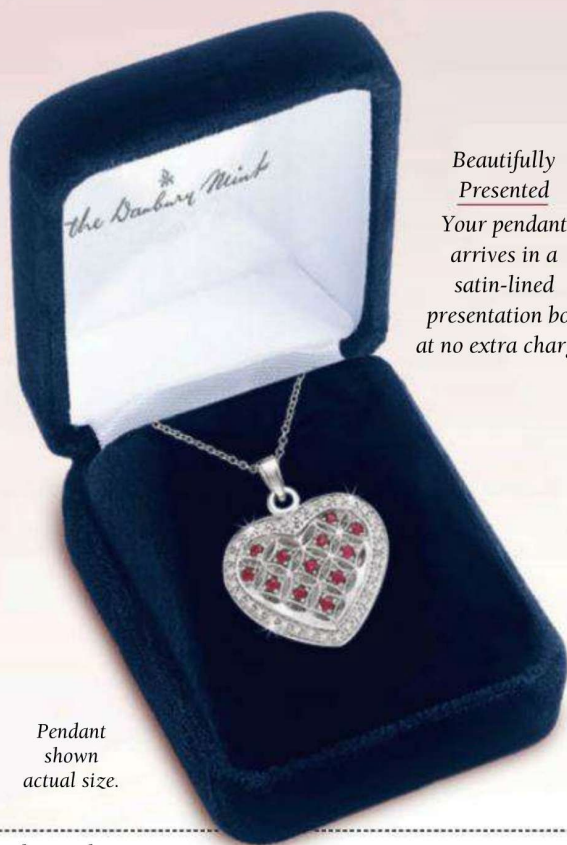
This stunning pendant features elegant sterling silver plating and 32 simulated diamond accents. Twelve rubies are nestled within the pendant, just as your daughter is nestled forever in your heart. Hanging gently on an 18-inch chain, this pendant beautifully puts into words all that she means to you.

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The pendant can be yours for \$99 plus \$7.50 shipping and service, payable in three monthly installments of \$35.50. Your satisfaction is guaranteed. If you are not completely delighted, return the pendant within 90 days for replacement or refund. For the next special occasion or as a wonderful surprise, don't delay — order today!



The back is beautifully engraved with a loving sentiment.



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98260011E021

DIY

Home OUTDOOR PLAY SET

brackets. We spent about \$350 on lumber and got to work. Two people can put up this play set in a day and a half to three days, depending on their skill level. But we suggest you take your time and get the kids involved. For them, the only thing better than playing on it may be knowing they helped build it.

Construction Sequence

BUILD THE FORT

→ I cut most of the swing set parts in the garage. Where possible, I bored holes for lag screws and bolts and test-fitted subassemblies, then carried these outside.

To build the elevated fort, take four 4 x 4 posts, two 2 x 4 tarp boards, and two 2 x 6 sandbox boards and fasten them together into subassemblies, each consisting of a pair of posts, a sandbox board, and a tarp board.

Stand these subassemblies up and brace them in position, then span a horizontal 4 x 4 deck support between each pair of posts. With the holes prebored in each deck support, level it and clamp it into position. Use the bolt holes in the support to mark the position of the holes in the posts. Remove the support, drill the holes through the posts, then bolt the deck supports in place.

Next, erect the canopy posts. Bore bolt holes through the deck supports and through the posts. Loosely bolt each canopy post in position. Span between the canopy posts with a 2 x 4 brace across their tops and



lag-screw it to the post ends [1]. Stand the canopy posts upright and use a 4-foot level to ensure they're plumb, then tighten the nuts on the bolts.

Next, fasten the deck boards to the deck supports and install the deck stringer. Note that eight of the 11 deck boards are cut from 2 x 6s. Three others, called out separately in the materials list as deck spacers, are cut from 2 x 4s and are positioned between the fort posts and the canopy posts. This creates a neat and evenly spaced deck floor.

Install the panel boards and wall panels [2]. Build the ladder and install it [3]. Notch the top of one of the ladder legs to get the ladder to fit properly (see the detail view in our illustration).

INSTALL THE SWING BEAM

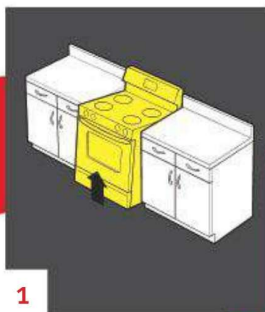
→ Fasten the six swing hangers to the swing beam. Then join together the two 4 x 4 swing-beam legs using the leg bracket [4]. Mount the swing-beam support on the fort, then screw the swing-beam bracket to the support. With a helper, stand the swing-beam legs upright and position the beam. Fasten the swing beam to the leg bracket and to the support bracket [5], then level the beam [6].

Finally, install the swing-beam cross support on the legs, the safety board adjacent to the sandbox, the front panel board above the slide, and the remaining boards for the sandbox. Run a lumber border around the play area and spread wood chips throughout, then fill the sandbox with sand. Install the remaining hardware and attach the wave slide to the fort. Final step: Play with your kids. **PM**

Homeowners Clinic

by Roy Berendsohn

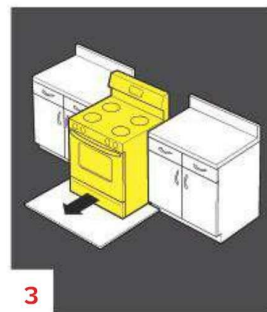
THE ELECTRIC SLIDE



1
LIFT UP front feet of range.



2
SLIDE hardboard under front feet.



3
LIFT range and SLIDE it forward.

Make Your Move

I'm remodeling our kitchen, one bathroom, and the laundry room. While moving appliances around, I damaged our vinyl floors in two different places. I hid the laundry room tear by slightly repositioning the washer, but the damage in the kitchen is still visible. First, how can I fix the flooring? Second, how should I move appliances next time?

A Small repairs to vinyl floors are relatively easy to fix with a kit. You can buy a pro-quality kit from Cal-Flor Accessory Systems (Flooring Repair Kit, about \$93, plus shipping). A less expensive DIY version can be purchased from Lifetime Repair Kits (Vinyl Floor & Tile Repair Kit, about \$10).

For future moving jobs, keep in mind that a dirty floor is a damaged floor. Dirt and grit under the foot of an appliance can increase the friction enough to rip vinyl pretty easily. So the first step in rearranging appliances is to damp-mop the floor. When it's dry, lay down a piece of $\frac{1}{8}$ -inch hardboard (often referred to as Masonite), shiny side up. Lift or lever the appliance and lower it onto the hardboard, then gently coax the appliance forward. For really heavy machines, slip a furniture glide under the front feet once you get the appliance onto the hardboard. Slide the appliance forward and place two glides under the back feet.

Can you move an appliance using the furniture glides alone? Maybe. I once flipped a scrap of carpet upside down and moved around a kitchen range like nobody's business. (That method depends on the quality of the carpet. If an appliance foot punches through, it could wreck the floor.) Given that a half-sheet of $\frac{1}{8}$ -inch hardboard costs only \$10, it's inexpensive insurance.

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DIY

Home HOMEOWNERS CLINIC Q+A



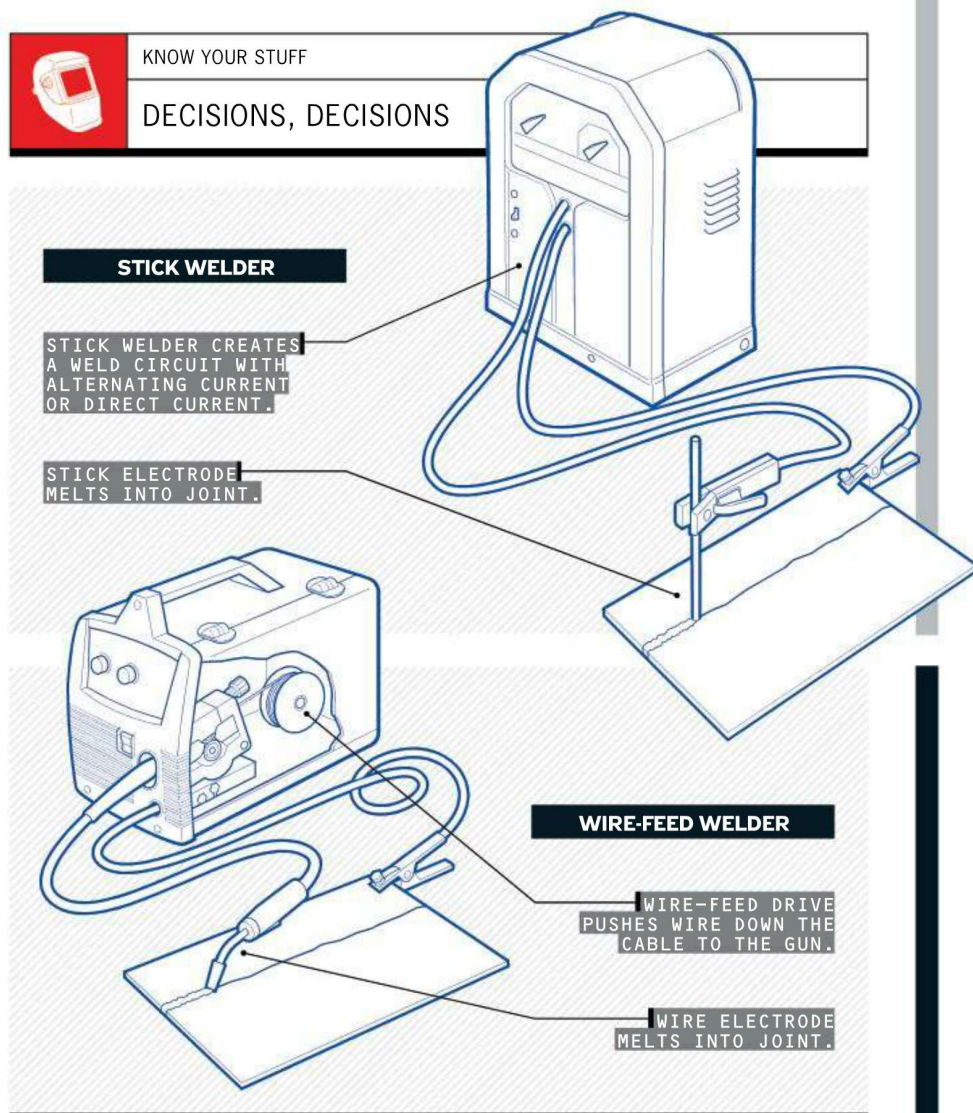
KNOW YOUR STUFF

DECISIONS, DECISIONS

STICK WELDER

STICK WELDER CREATES
A WELD CIRCUIT WITH
ALTERNATING CURRENT
OR DIRECT CURRENT.

STICK ELECTRODE
MELTS INTO JOINT.



WIRE-FEED WELDER

WIRE-FEED DRIVE
PUSHES WIRE DOWN THE
CABLE TO THE GUN.

WIRE ELECTRODE
MELTS INTO JOINT.

I LIKED YOUR RECENT WELDER TEST (SEPTEMBER 2011), BUT IT DIDN'T HELP ME CHOOSE BETWEEN A STICK WELDER AND A WIRE-FEED WELDER. CAN YOU EXPLAIN THE STRENGTHS AND DRAWBACKS OF EACH?

Wire-feed welders are great, but there's a lot to be said for stick welders, which use a rod-shaped electrode held in a clamp. Here's how it works: A ground lead runs from the welding machine to the workpiece. When you touch the stick electrode to the metal, you make a welding circuit and create a high-temperature arc that melts the rod. As the electrode melts, the flux coating on it is gasified, shielding the molten metal from the air.

When the metals cool, they are fused together. A major advantage of stick welding is that you can easily switch among various electrodes. For example, some achieve high-strength joints; others repair cracked cast iron or fill in pitted areas. Also, there are stick electrodes designed to deal with rust or dirt, a good thing when you're repairing a machine outdoors where achieving a clean weld surface is impossible.

The downside to stick

welders is that they are more difficult to learn to use, especially if you're teaching yourself.

Wire-feed welders are more mechanically complex, but they're simpler to operate. These machines drive a thin wire electrode off a motorized spool and through a cable to a welding gun.

And wire-feed welders can join metal ranging from automotive sheet steel all the way up to ½-inch-thick plate.

Here's a final point. Vinyl floors are especially prone to damage from pivoting, which causes the appliance feet to grind into the surface. So avoid that motion as much as possible.

Start Digging . . . 🛠️ **The sink and the toilet in one of our bathrooms don't seem to be draining properly, and I've noticed a mushy spot in the backyard between the house and the septic tank. I'm thinking that the pipe is clogged or broken, but give me your take on this.**

My take is that you're right. The pipe between the bathroom and the septic tank is cracked, broken, or infiltrated by tree roots. Any type of sewer pipe (cast iron, asphalt-impregnated fiber, or clay) can fail after decades of use, though, generally speaking, cast iron and clay are far more durable than the asphalt-impregnated fiber, which is often called Orangeburg. There's no easy repair. If the pipe is cast iron, you can cut out the damaged section and splice in a new piece of cast-iron pipe and no-hub fittings (fittings with large, bolt-on rubber gaskets that seal the joint and prevent leaks while maintaining flexibility). You'll need specialty rental tools to cut the cast-iron pipe, though. The most important piece of equipment will be a soil-pipe cutter (also called a snap cutter).

If the pipe is clay or asphalt-impregnated fiber, you should replace the entire run of pipe from the house to the septic tank. Unless you're an accomplished do-it-yourselfer, hire a plumber to do this, and maybe even a backhoe operator.

One word of advice: If you're brave enough to make this dirty, smelly repair yourself, be sure that no one in the house drains a sink, showers, or runs a dishwasher while you're down in the hole. And this is to say nothing of flushing a toilet. Not to get too graphic here, but getting splattered by a flushed toilet is worse than the repair.

Helping Mom 🛠️ **My mom has an aluminum awning over her patio.**

Rainwater and melting snow run down to the awning's edge to a channel and then into downspouts. The channel gets clogged with leaves and then water overflows rather than going into the downspouts. What's the solution? I'd make a cover for the channel out of galvanized-steel mesh. Fold the mesh into a V shape and make mesh flaps to cover the ends. Also, make sure to keep the awning clear of leaves by occasionally sweeping over it with a small electric leaf blower. Finally, it sounds like some tree-branch trimming is in order. That should help, at least a little.

Cold-Weather Skeeters 🦟

I live in Minnesota and have a problem with mosquitoes inside the house. Months after summer has passed I'll see a mosquito fly out of a sink drain. Other times I see them early in the spring. How can I stop them from getting in?

I hate to tell you this, but they're probably breeding inside the house (cue the omi-

nous music). The northern house mosquito (*Culex pipiens*) is a species that spends winters inside, often in basements, breeding in sink drains or in a puddle of water at the base of a houseplant. People can be caught off-guard when these mosquitoes emerge early in the spring, late in the fall, or at times, during a winter thaw.

The good news is that you can control their numbers as you would with any other type of mosquito. Ensure there is no standing water (such as in basement utility sinks) inside the house. Cover floor drains that are rarely used and occasionally pour a bucket of water into the trap to flush out standing water and refill the trap. Take similar precautions with basement utility sinks. Also make sure to eliminate standing water outside the house. Mosquitoes can breed in a birdbath or in a puddle at a low spot in the lawn.

House mosquitoes aside, if you find flying insects entering your home through sink drains, you probably have

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a dry trap; the pests have likely come through a roof vent stack. Another sure indicator of a dry trap is the smell of sewer gas. A properly operating drain system will have water-filled traps that block insects and odors. Have a plumber evaluate your drain system.

Yankee Dandy ➔ A

friend gave me a box of old tools, including a pair of Yankee screwdrivers that are in pretty good shape. Are the Yankees worth bothering with? I see there are adapters that enable them to take hex-shank bits, but I already own a good cordless drill with two batteries.

Developed around the turn of the last century, the Yankee was the original powered screwdriver—powered, that is, by you. Push down on its handle and the tool converts your downward force to torque by means of a spring-loaded spiral driveshaft that telescopes into the screwdriver's long, hollow barrel. You can also lock the drive mechanism and use the Yankee as a large ratcheting screwdriver. That's how I use mine. The design is ingenious, and the tool enjoyed decades of success until it was supplanted by the cordless drill driver. The problem with a Yankee is that its range is limited. It works best with small screws driven into a precisely bored hole. For example, I just used mine to partially back out and redrive the mounting screws for six hard-wired smoke detectors that I replaced. I find the tool works well for some oddball jobs where space is limited and you need precision.

Still, is it worth carrying in your tool kit? Maybe. If you have a sentimental streak like me,



YANKEE
SCREWDRIVER

you might want to keep one. I recently restored a Yankee with my teenage son, Joe. It was owned by his great-grandfather, a *POPULAR MECHANICS* reader and a highly competent self-trained craftsman who did everything from repair his boat to fix his car.

Restoring that tool made me appreciate the one I own, so I bought an adapter for it. Now I use the Yankee a couple of times a year.

In most cases, though, there's no contest between that tool and a cordless drill driver when it comes to versatility, speed, power, and precision. The chief benefit of a drill driver is that it is just as effective at boring holes as it is at driving screws. And, of course, just the opposite is true of the Yankee: It's far better at driving than drilling.

Fan Clubbed ➔ We're fixing up our old house, and one of the first fixes I want to make is to stop the upstairs bathroom fan from discharging into the attic. When the fan is off, condensation drips from it into the room below. As a stopgap measure, I think I'll just leave the fan running to increase airflow from the bathroom and out the attic vents. Will this work to reduce the condensation problem?

It might stop the dripping condensation, but a bath fan isn't designed to run nonstop. It's a little-known fact that overheated bath fans are frequently the source of house fires. They're often badly installed, clogged with lint and dust, or simply overworked. People let them run to provide constant air circulation, but they're not built to handle such use, and this can lead to overheating. In fact, two recent fires near me have been traced to overheated bath fans.

The solution to your problem is to install a proper exit for the fan, either through the roof or through a sidewall. (It's actually a building-code violation to discharge the bath fan into the attic.) You'll probably also want to replace the fan itself. I'm willing to bet it's worn out from all that condensation. If nothing else, remove the fan and give it a thorough cleaning.

Finally, as part of this project, have a careful look around the attic. It's not unusual to find delaminated roof sheathing and mildew growing in attics into which the fan has been discharged, two problems you'll need to address separately.

Kill Hornets, Not Your Siding ➔ I used some hornet killer and although it took care of the bug problem, it seems to have stained my vinyl siding and windows. Can these stains be removed?

It's possible that a strong cleaner-degreaser might remove the residue but I suspect not. I've seen several instances where this stuff has stained siding, windows, and trim—not just vinyl but also painted wood and aluminum. Don't get me wrong, I'm not recommending that people stop using insecticides and other products. Short of calling an exterminator (which is not a bad idea in many cases), they're the only safe way of dealing with these pests. So how do you use them? First, check whether an insecticide has warnings that it may stain siding or damage windows. After you kill the bugs, wash and rinse the surrounding surface to remove any pesticide residue.

PM

Got a home-maintenance or repair problem? Ask Roy about it.

Send your questions to pmhomeclinic@hearst.com or to Homeowners Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we cannot answer questions individually, problems of general interest will be discussed in the column.





MEN DON'T LOOK FOR EXCUSES. THEY GET THINGS DONE.

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So if you're like millions of men who have some degree of erectile dysfunction (ED), talk to your doctor about VIAGRA. It's America's most prescribed ED treatment. VIAGRA can work in 30 to 60 minutes and, for some men, in as little as 14 minutes.*

For more information go to viagra.com or call 1-888-484-2472 (1-888-4VIAGRA).

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(sildenafil citrate) tablets

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We know that no medicine is for everyone. Don't take VIAGRA if you take nitrates, often prescribed for chest pain, as this may cause a sudden unsafe drop in blood pressure.

Talk with your doctor first. Make sure your heart is healthy enough to have sex. If you have chest pain, nausea, or other discomforts during sex, seek medical help right away.

In the rare event of an erection lasting more than four hours, seek immediate medical help to avoid long-term injury.

In rare instances, men who take PDE5 inhibitors (oral erectile dysfunction medicines, including VIAGRA) reported a sudden decrease or loss of vision, or sudden decrease or loss of hearing. It is not possible to determine whether these events are related directly to these medicines or to other factors. If you experience any of these symptoms, stop taking PDE5 inhibitors, including VIAGRA, and call a doctor right away.

The most common side effects of VIAGRA are headache, facial flushing, and upset stomach. Less common are bluish or blurred vision, or being sensitive to light. These may occur for a brief time.

VIAGRA does not protect against sexually transmitted diseases including HIV.

Take VIAGRA about one hour before you want to have sex. VIAGRA works for 4 hours. VIAGRA only works with stimulation.

Please see Important Facts for VIAGRA on the following page or visit viagra.com for full prescribing information.

*Data taken from a study of 228 men with ED who previously had success with VIAGRA. Of the 115 men who took VIAGRA 100mg, 35% had erections hard enough for successful intercourse at 14 minutes, and 51% of men at 20 minutes.

Individual results may vary.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.FDA.gov/medwatch or call 1-800-FDA-1088.

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IMPORTANT FACTS

VIAGRA®
(sildenafil citrate) tablets

(vi-AG-rah)

IMPORTANT SAFETY INFORMATION ABOUT VIAGRA

Never take VIAGRA if you take any medicines with nitrates. This includes nitroglycerin. Your blood pressure could drop quickly. It could fall to an unsafe or life-threatening level.

ABOUT ERECTILE DYSFUNCTION (ED)

Erectile dysfunction means a man cannot get or keep an erection. Health problems, injury, or side effects of drugs may cause ED. The cause may not be known.

ABOUT VIAGRA

VIAGRA is used to treat ED in men. When you want to have sex, VIAGRA can help you get and keep an erection when you are sexually excited. You cannot get an erection just by taking the pill. Only your doctor can prescribe VIAGRA.

VIAGRA does not cure ED.

VIAGRA does not protect you or your partner from STDs (sexually transmitted diseases) or HIV. You will need to use a condom.

VIAGRA is not a hormone or an aphrodisiac.

WHO IS VIAGRA FOR?

Who should take VIAGRA?

Men who have ED and whose heart is healthy enough for sex.

Who should NOT take VIAGRA?

- If you ever take medicines with nitrates:
 - Medicines that treat chest pain (angina), such as nitroglycerin or isosorbide mononitrate or dinitrate
- If you use some street drugs, such as “poppers” (amyl nitrate or nitrite)
- If you are allergic to anything in the VIAGRA tablet

BEFORE YOU START VIAGRA

Tell your doctor if you have or ever had:

- Heart attack, abnormal heartbeats, or stroke
- Heart problems, such as heart failure, chest pain, or aortic valve narrowing
- Low or high blood pressure
- Severe vision loss
- An eye condition called retinitis pigmentosa
- Kidney or liver problems
- Blood problems, such as sickle cell anemia or leukemia
- A deformed penis, Peyronie’s disease, or an erection that lasted more than 4 hours
- Stomach ulcers or any kind of bleeding problems

Tell your doctor about all your medicines. Include over-the-counter medicines, vitamins, and herbal products. Tell your doctor if you take or use:

- Medicines called alpha-blockers to treat high blood pressure or prostate problems. Your blood pressure could suddenly get too low. You could get dizzy or faint. Your doctor may start you on a lower dose of VIAGRA.
- Medicines called protease inhibitors for HIV. Your doctor may prescribe a 25 mg dose. Your doctor may limit VIAGRA to 25 mg in a 48-hour period.
- Other methods to cause erections. These include pills, injections, implants, or pumps.
- A medicine called REVATIO. VIAGRA should not be used with REVATIO as REVATIO contains sildenafil, the same medicine found in VIAGRA.

POSSIBLE SIDE EFFECTS OF VIAGRA

Side effects are mostly mild to moderate. They usually go away after a few hours. Some of these are more likely to happen with higher doses.

The most common side effects are:

- Headache
- Feeling flushed
- Upset stomach

Less common side effects are:

- Trouble telling blue and green apart or seeing a blue tinge on things
- Eyes being more sensitive to light
- Blurred vision

Rarely, a small number of men taking VIAGRA have reported these serious events:

- Having an erection that lasts more than 4 hours. If the erection is not treated right away, long-term loss of potency could occur.
- Sudden decrease or loss of sight in one or both eyes. We do not know if these events are caused by VIAGRA and medicines like it or caused by other factors. They may be caused by conditions like high blood pressure or diabetes. If you have sudden vision changes, stop using VIAGRA and all medicines like it. Call your doctor right away.
- Sudden decrease or loss of hearing. We do not know if these events are caused by VIAGRA and medicines like it or caused by other factors. If you have sudden hearing changes, stop using VIAGRA and all medicines like it. Call your doctor right away.
- Heart attack, stroke, irregular heartbeats, and death. We do not know whether these events are caused by VIAGRA or caused by other factors. Most of these happened in men who already had heart problems.

If you have any of these problems, stop VIAGRA. Call your doctor right away.

HOW TO TAKE VIAGRA

Do:

- Take VIAGRA only the way your doctor tells you. VIAGRA comes in 25 mg, 50 mg, and 100 mg tablets. Your doctor will tell you how much to take.
- If you are over 65 or have serious liver or kidney problems, your doctor may start you at the lowest dose (25 mg).
- Take VIAGRA about 1 hour before you want to have sex. VIAGRA starts to work in about 30 minutes when you are sexually excited. VIAGRA lasts up to 4 hours.

Don't:

- Do not take VIAGRA more than once a day.
- Do not take more VIAGRA than your doctor tells you. If you think you need more VIAGRA, talk with your doctor.
- Do not start or stop any other medicines before checking with your doctor.

NEED MORE INFORMATION?

- This is only a summary of important information. Ask your doctor or pharmacist for complete product information OR
- Go to www.viagra.com or call (888) 4-VIAGRA (484-2472).

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DIY

Tech



Five Rules for Internet Safety

THE BEST DEFENSE AGAINST PHISHING, MALWARE, DATA THEFT, AND PRIVACY INVASION IS YOU.

BY JOHN HERRMAN

➔ **There is such a thing** as an Internet Safety class. In some states, it's even required in high school. The Virginia Department of Education's website is full of materials for teachers, including documents such as "Sexting: Implications for Schools" and "Cyberbullying and School Policy." These are the digital equivalent of a self-defense class. Common online threats are less sensational—and, thankfully, preventable. Though the problems are technological, the solutions are behavioral. Just five rules can help anyone stay safe online.

INSIDE

× AUDIO BRANDING + PHOTO SHRINKAGE + UNLOCKED PHONES



CREATING A BUZZ!

Build a simple door alarm

DIFFICULTY LEVEL:
●○○ EASY

PARTS

- | | |
|---|---|
| ☐ Project Enclosure (3x2x1") | ☐ 22-Gauge Speaker Wire |
| ☐ Project Enclosure (5x2.5x2") | ☐ Heat-Shrink Tubes |
| ☐ 75dB Piezo Electric Buzzer | ☐ 2 "AA" Batteries |
| ☐ Lever Switch | ☐ Double-Sided Tape or Glue Dots |
| ☐ SPDT Toggle Switch | ☐ 2x0-80 3/8" |
| ☐ 2-"AA" Battery Holder | ☐ Screws and Nuts |

Want to protect your room from a sneaky sibling? Here's a fun, easy project that lets out a buzz whenever someone opens your door.

To detect the position of the door, we'll be using a lever switch. This is a type of momentary switch, which means it's normally in one position, and only stays in the other position as long as its physically held in place. Because it's an SPDT (single-pole, double-throw) switch, it can be wired up to be either normally-on or normally-off. We'll be using it in normally-on mode. (For more about types of switches, see the online instructions.)

First, we'll need to extend the reach of the lever switch so it will make contact with the door. One way to do this is with a paper clip. Unbend the clip and attach it to the lever with some two-part epoxy, holding it in place with a set of Helping Hands while it cures.

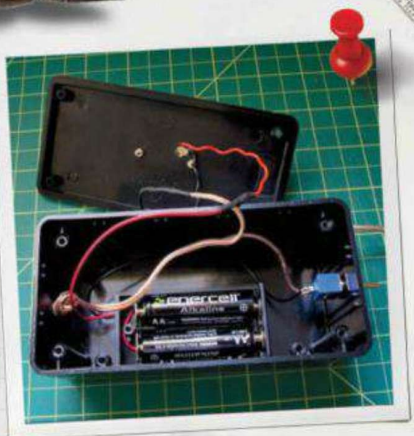
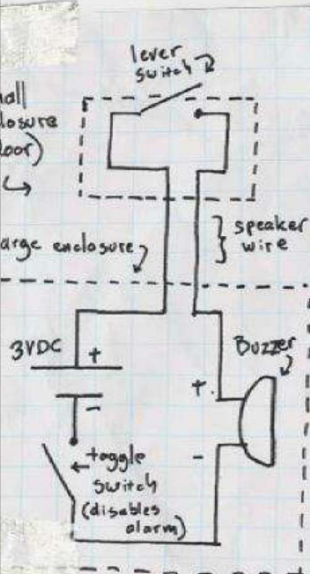
The smaller project enclosure will contain the lever switch. Drill a hole in one side large enough to allow free movement of the lever switch, and a smaller hole on the other side for the wire that leads back to the alarm box.

The larger enclosure will contain the buzzer, battery holder and a toggle switch for arming or disarming the alarm. Drill holes in the sides for the speaker wire and toggle switch. On the lid, drill two small holes for mounting the buzzer and a larger hole for the buzzer's lead wires. Mount the buzzer to the outside of the lid, passing the leads through to the inside.

Cut a piece of speaker wire about six feet long and feed a few inches through a hole in each box, tying a knot on the inside to relieve strain. In the smaller enclosure, solder the leads to the two outside solder tabs of the lever switch. In the larger enclosure, solder the battery holder, buzzer, toggle switch and speaker wire together according to the circuit diagram. Make sure the polarity is correct for the buzzer and battery pack. (For more about soldering wires together, see the online instructions, but make sure you protect the connections with heat-shrink tubing!)



California residents: WARNING: These products contain, or when used for soldering and similar applications produce, chemicals known to the State of California to cause cancer and birth defects (or other reproductive harm).

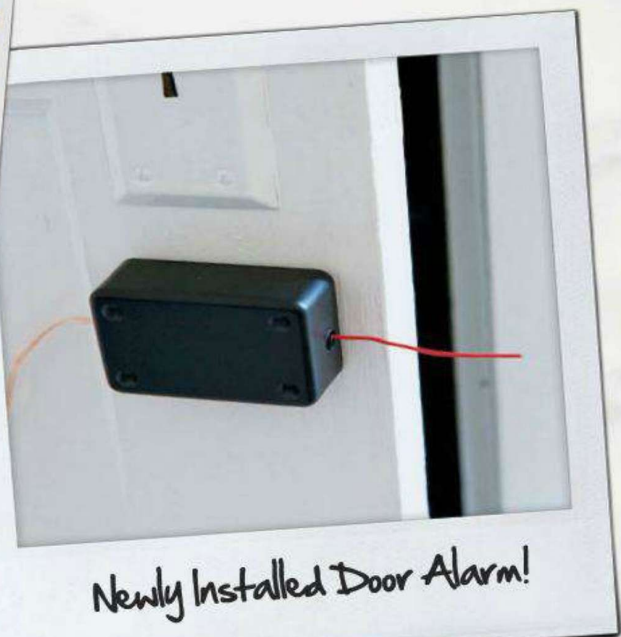


Give everything a test: With the toggle switch on, the buzzer should make a sound when the lever switch is not depressed.

Mount everything in place inside each box.

(A dollop of hot glue can be used to mount the lever switch and battery holder.)

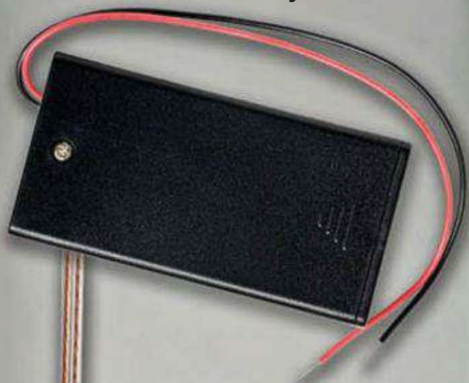
The lever box can be mounted on the door with double-sided tape or glue dots. Position it so the switch is turned off when the door is closed, carefully bending the clip as needed. Opening the door should now trip the alarm. Intruders beware!



Newly Installed Door Alarm!

CREATING A BUZZ FEATURES THESE RadioShack PARTS:

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Lever Switch



2 “AA” Batteries



SPDT Toggle Switch

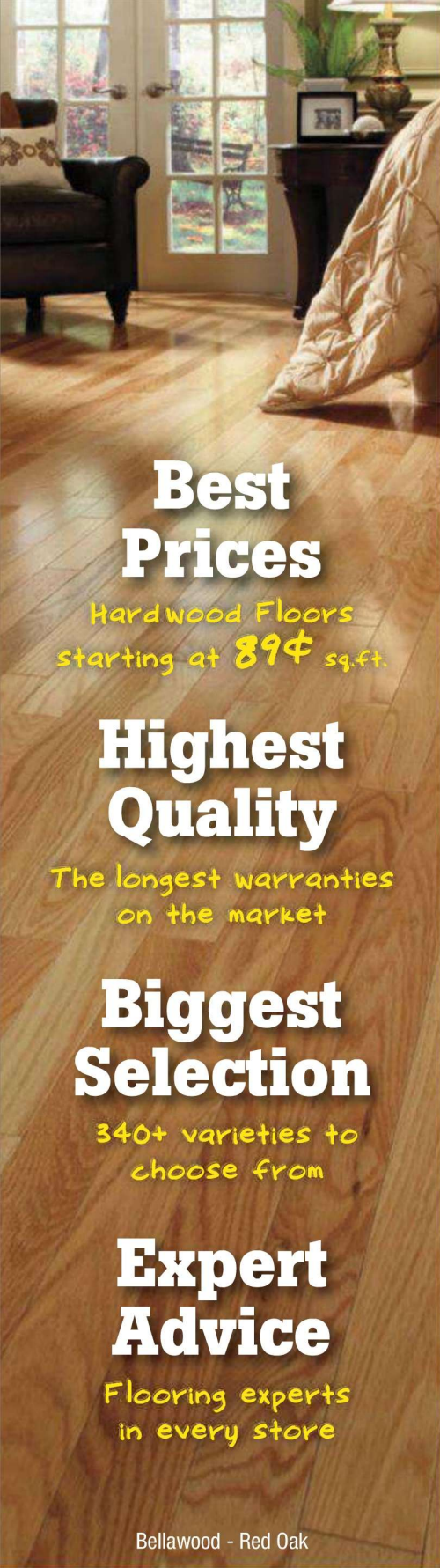
22-Gauge Speaker Wire

To see “how-to” video footage for this project and explore other great creations, visit RadioShack.com/DIY



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DIY Tech INTERNET SAFETY

Change Your Passwords

➡ **"Change your passwords"** is the "eat your vegetables" of the tech world—we all know we should do it, yet most people don't. But changing passwords addresses only part of the problem: There's not much point in switching to new passwords if they're not good ones, or if you're using the same one for every account.

What you're trying to fend off isn't some hacker hellbent on guessing or decoding your password; a more realistic concern is that, when a large website you use gets hacked, an opportunistic criminal could take the leaked information—your username, email, and password—and try it out on other sites.

An ideal password strategy looks something like this: new, 20-character alphanumeric passwords for each of your online accounts every month. A more reasonable strategy might look like this: new, six-character alphanumeric passwords for each of your accounts every three months. No strategy is foolproof, but *no* strategy is foolish.

Learn Email Forensics

➡ **It's always a little funny** to get an email from a bank you don't use, asking for information about an account you don't have. This kind of scamming, or phishing, is often clumsy to the point of absurdity.

What's less funny is when the bank *is* your bank, and the email looks legitimate. Some phishing scams replicate organizations' emails exactly and even spoof email addresses. There are a lot of ways to identify this advanced kind of phishing attack, but there's one technique that's guaranteed to work: checking email headers.

Think of email headers as bread crumbs showing the path of the message from its origin. The method for finding headers differs from program to program, but it's usually somewhere in the View menu—in Gmail, it's labeled Show Original and hidden in a drop-down menu for each email. Once you see the headers—they look like lines of code—look for a line that says "Received from." If the address doesn't match the organization the email is allegedly from, you've hooked a phish(er).

Cover Your Tracks

➡ **Free websites are supported by ads**, and Web ads are much more valuable to the advertiser if they're well-targeted. Using files called tracking cookies, websites gather information about your browsing habits to serve relevant ads elsewhere. Searching for a product on Amazon can result in ads for that product appearing on Google. Search something on Google and you might see it again on Facebook.

The best way to stop this tracking is to install a browser add-on. Firefox users can download a free extension called Priv3 that limits the ability of social networking sites and search engines to track your online movements. Chrome users should try Adblock Plus, which can be used to prevent tracking or block ads altogether. (Remember, though, most of your favorite sites depend on ad revenue to survive.)

Insist on Encryption

➡ **A typical interaction with a website** goes like this: You either click on something or enter text into a box. This information is then sent over your Internet connection—often through a Wi-Fi network—to the website you're looking at. The problem with this system is that the information sent back and forth between user and site, including passwords, can be exposed to other people on the same network. The availability of free "packet-sniffing" tools, such as the Firefox extension Firesheep, has made stealing information on public networks (coffee shops, airports) frighteningly easy.

Legitimate sites that request private information will almost always use something called SSL, which is a protocol for encrypting data before it's transmitted from user to website and vice versa. A site that's using SSL will have two qualities:

SECURITY ALERT

GADGET THEFT

✕ Computers offer instant access to the most intimate details of our modern lives. Laptops let us take our computers almost anywhere. Combine those two truisms and you see the unique vulnerability that laptops present. Access to all your files, stored passwords, bookmarks, and financial info by a stranger is only one inattentive moment away. Here's what you can do after the fact—and, for that matter, before the fact.

What to do if your laptop gets stolen:

Change your passwords: Lock down your email account first, as it likely contains info about other accounts.

Notify your bank, credit card company, and others: Almost anything you've accessed on your laptop is at least a little vulnerable. Consider a fraud-alert service.

Call the police: Not because you're likely to get your laptop back, but as a matter of principle.



What to do BEFORE your laptop gets stolen:

Require a password: Not just to log in, but every time the laptop screen is opened. There's one downside to this: Laptop-tracking software such as LoJack and Find My Mac won't function without an Internet connection, and password protection will likely prevent a stolen laptop from connecting to the Internet.

Back up everything: This is a good habit for any computer, but especially for theft-prone laptops.

Attach contact information: Just in case your "theft" turns out to have been a misunderstanding. An email address will do just fine.

Its URL will start with https instead of http, and there will be a small padlock icon next to its URL in the address bar of your browser. If the lock is broken, or red, the site's SSL certificate—which must be issued by a trusted third party—is either expired or invalid. In other words, your data is not safe.

Some sites that support SSL for logins and transactions might not support it for all site functions. To trick a site into using SSL, simply add an "s" to the "http" in the URL. If the site supports SSL, your inputs will be encrypted. (Firefox users can install the "HTTPS Everywhere" add-on, which automates this process.)

Manage Your Identities

⚙️ **Anything you post on a social network** can be used against you in a court of... well, anywhere with an Internet connection. On your Facebook page, or your Twitter feed, or your LinkedIn account, exercising caution is common sense.

As they've become more popular, these social networks have grown deep roots in the Internet. Countless third-party sites depend on users' Facebook accounts, Google logins, and Twitter handles to register for new services or to leave comments. If you've logged in to a site using an account that's associated with your real name, you should assume that everything you post can be traced back to you, be it a silly joke or an overly casual comment.

If you don't want to use your real name to, say, comment on a news story, see if the site allows you to create a separate account with an email address. If a site requires a social network account, make a dummy. Twitter and Google don't mind if you set up an account with an alias. Facebook doesn't allow it, but they don't really check either. **PM**

TOUGHEST ON THE BLOCK



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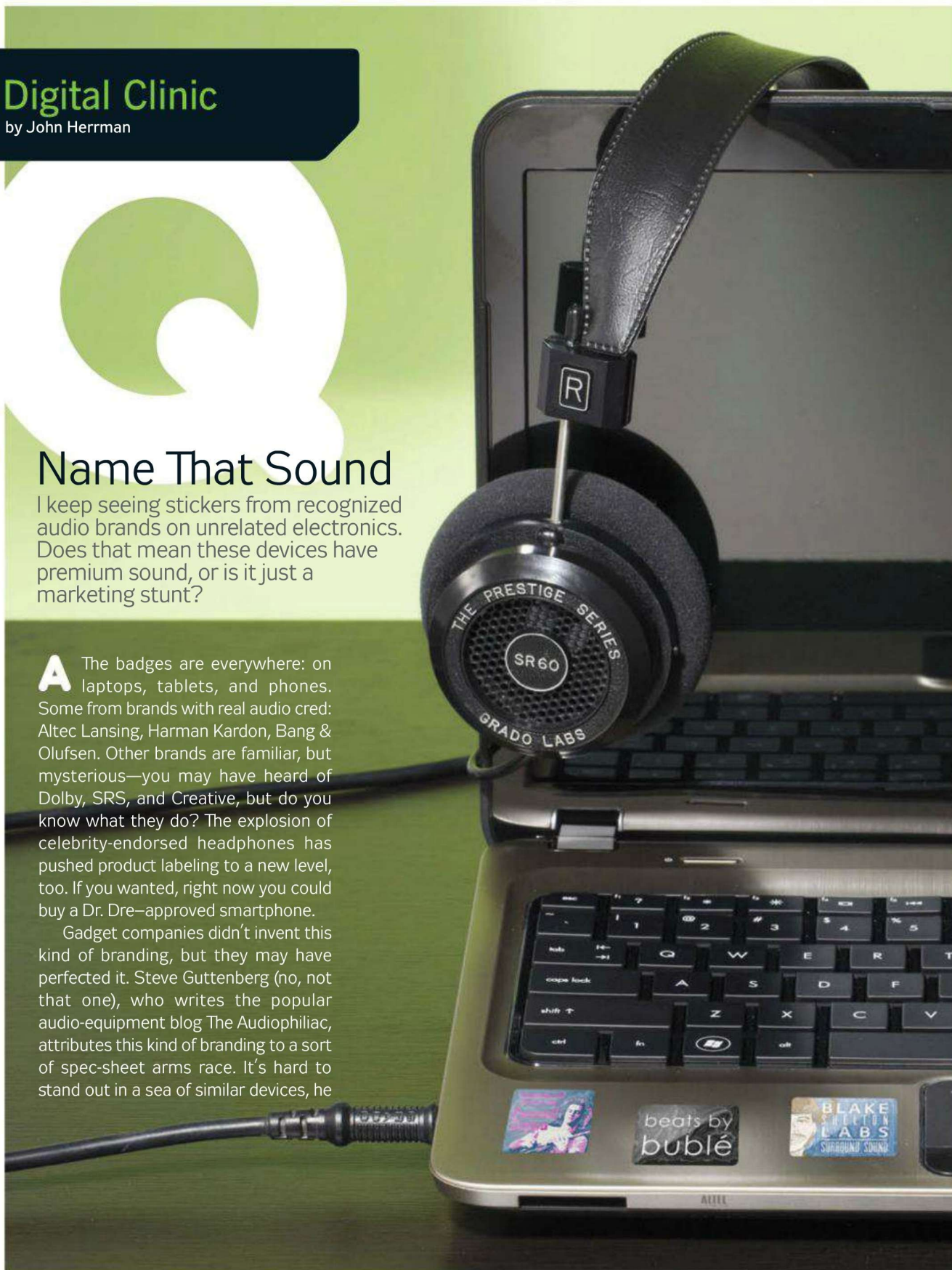
by John Herrman

Name That Sound

I keep seeing stickers from recognized audio brands on unrelated electronics. Does that mean these devices have premium sound, or is it just a marketing stunt?

A The badges are everywhere: on laptops, tablets, and phones. Some from brands with real audio cred: Altec Lansing, Harman Kardon, Bang & Olufsen. Other brands are familiar, but mysterious—you may have heard of Dolby, SRS, and Creative, but do you know what they do? The explosion of celebrity-endorsed headphones has pushed product labeling to a new level, too. If you wanted, right now you could buy a Dr. Dre-approved smartphone.

Gadget companies didn't invent this kind of branding, but they may have perfected it. Steve Guttenberg (no, not that one), who writes the popular audio-equipment blog *The Audiophile*, attributes this kind of branding to a sort of spec-sheet arms race. It's hard to stand out in a sea of similar devices, he



PHOTOGRAPH BY PHILIP FRIEDMAN

says, so "everybody is trying to sell by adding features." Hence the over-the-top stickers, decals, and inscriptions.

Generally speaking, a device with special audio branding *will* sound different from an equivalent device without it. There's a good chance that it will sound noticeably better, too: Bass may be fuller, and highs a bit clearer. But what you're hearing isn't necessarily better hardware. Often, it's software.

There are certain limitations to designing an amp and a speaker system to fit inside a portable device, Guttenberg says, such as diminutive speaker size and extremely limited power supply (laptop speakers rarely exceed 5 watts). Most important, there's the issue of cost: A teardown of a typical \$500 laptop leaves you with a bill of materials of about \$350. Of that, less than \$10 is spent on audio. (The small-quantity wholesale price on alibaba.com for a Realtek ALC268 audio processor and pair of laptop speakers comes to \$7.84.) Shifting that sum upward by a few dollars, however, won't dramatically improve sound quality.

What you usually get when you buy a device with branded audio is special audio processing. Take, for example, the HTC Sensation XE, the first Android phone branded with Beats Audio. While the handset ships with better-than-average earbuds, its own audio hardware is undistinguished. The Beats Audio component of the phone is mainly software—in effect, an equalizer. The buds are nice but they're an accessory.

That's not to say branded audio is something you should avoid—just that there usually isn't much hardware behind that sticker and it isn't worth paying extra for. With a little tinkering you can often reproduce "exclusive" audio-processing effects by adjusting the software equalizer in your music-player app of choice.

Neg-a-Pixels ➔ My friend told me that choosing a smaller picture size in my camera setting would result in cleaner, less noisy low-light photos. Is this true?

Your friend is sort of right but only in theory. Like film, a digital-camera sensor collects light. Unlike film, a camera sensor has to split that light into individual, discrete pixels. If you decrease the number of pixels that a sensor needs to create, it seems like more of the surface of the sensor could be devoted to each pixel. More surface area means more light absorption, which means better low-light photos.

Here's the thing: Camera sensors *are* the number of megapixels of the photos they produce. Think of the pixels as little buckets: A 10-megapixel camera actually has 10 million of them, and they can't change size. Some pro-grade cameras can group clusters of pixels to achieve the effect your friend is talking about. But the majority of cameras, when turned to a lower megapixel setting, will either capture a full-resolution image and rescale it or simply use less of the sensor. Different image-size options are included to save storage space, not to improve image quality.

Unlocked Secrets ➔ Sometimes at Best Buy and on Amazon I see

"unlocked" prices for cellphones. Why are they so high? Is it worth the money?

While we've come to tolerate them, cellphone economics are bizarre. A new phone might have an MSRP of \$700 but a contract price of \$200. The carrier doesn't mind eating some upfront cost knowing that it'll recoup it later in fees and overages.

Buying an unlocked phone is good for two things: keeping you out of a cellphone contract and using the device on a network for which it isn't officially available. In doing this you usually lose 3G or 4G capability—a big penalty for a smartphone. You also have only two choices: AT&T and T-Mobile. Unlocked handsets can't connect to Verizon or Sprint. **PM**

Got a technology problem?

Ask us about it. Send your questions to pmdigitalclinic@hearst.com.

While we cannot answer questions individually, problems of general interest will be discussed in the column.



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Sprucing Up Your Interior

WHAT DO YOU DO WITH A VEHICLE THAT WORKS FINE BUT LOOKS DISGUSTING? ONE MAN'S QUEST TO MAKE A BEATER SAAB PRETTY ON THE INSIDE. BY LARRY WEBSTER

➔ **The beauty of a \$2000 car** is that unless you blow it up, its value is pretty much fixed. You're free to experiment and learn. Take, for example, this 1986 Saab 900 Turbo—a winter beater destined to endure Michigan's salty winters while my primary car hibernates. On a scale of 1 to 10, the Saab's interior scored a -5. With a meager makeover budget, I combed craft stores, hobby shops, and auto parts depots to find materials for dirt-cheap repairs.



Saturday
Mechanic



degree of difficulty
MODERATE ● ● ●

Seats



PRO: \$50-\$200 / DIY: \$15

BEFORE

The Saab's torn seat hurt my eyes just to look at it, but the thought of draping a cheap, ill-fitting seat cover over it hurt even more. Higher-quality, fitted ones were simply out of my price range. But a trip to a craft store revealed another option.



AFTER

For \$7 I bought a curved upholstery needle and high-strength thread. I was planning to sew in a contrasting-color patch, but I was able to stretch the fabric and cover the hole. I finished by applying fabric cleaner with a terry-cloth rag.

INSIDE ✖

OIL ALERT + FINDING MYSTERY LEAKS + DON'T FIX IT

PHOTOGRAPHS BY BRIAN KELLY

Floor Console



BEFORE

Most of the Saab's switches—including the ignition—reside between the seats, where they often get fouled by spilled drinks. The previous owner had wired in a toggle switch to cycle the starter but had done a sloppy job. Also, the sleeves that cover the seatbelt latches were frayed.

AFTER

A new ignition module is \$250, so instead, I wired up a new toggle starter switch (\$12). Used window switches cost just 20 bucks, and I covered the seatbelt cables with heater hose, a \$2 fix. Then I lightly sanded and painted the plastic with black trim spray paint.

PRO: \$300-\$500 / DIY: \$45

Door Panel



BEFORE

Funny side note: My Saab was originally owned by John Oates from Hall & Oates ("private eyes, they're watching you..."). As befitting a rock star's car, the \$19,895 (about 33 grand today) 900 had luxury touches like velour door skins. But over time the foam backing deteriorated, leaving the material hanging and limp.

AFTER

At a fabric store I found corduroy the same hue as the original velour. I pulled off the panels, scraped off any residual foam, and then glued on the new material with 3M spray adhesive. It's simple: Coat both the fabric and panel, let the glue dry, and then join the two while smoothing with a credit card.

PRO: \$50-\$100 / DIY: \$12

BONUS BUDGET DIY TIPS



TIP 1 Pump up the jambs

The area where the door connects to the body is frequently forgotten, so give it a wipe; you see that junction every time you get into the car. While you're there, lubricate the hinges with white lithium grease.

TIP 2 Spray the rag

Whenever you're using a cleaning product on fabric or plastic, don't apply it directly to the surface. Instead, coat the rag first and then wipe; otherwise, concentrated cleaner could discolor the material.

TIP 3 Lube the seat tracks

Few things can make a car feel fresher than seats that effortlessly glide in their tracks. Move the seat all the way forward, dig the old grease from the tracks, and carefully reapply fresh lubricant.

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4000 LB. CAPACITY CABLE WINCH PULLER

LOT NO. 30329

SAVE 48%

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REG. PRICE \$24.99



For dead loads only; not for lifting.

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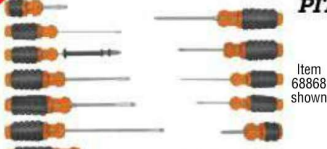
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One size fits all.



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CHICAGO ELECTRIC POWER TOOLS

SAVE 70%

Item 97626 shown

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SAVE 55%

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Includes one 18V NiCd battery and charger.

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CENTECH

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SAVE \$40

\$79.99

Requires four AA batteries (included).

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36 LED SOLAR SECURITY LIGHT
Bunker Hill Security

SAVE 28%

Item 98085 shown

\$17.99

REG. PRICE \$24.99

Includes 1.2 volt, 600mAh/6 volt NiCd rechargeable battery pack.



SUPER COUPON!

10 FT. x 10 FT. POPUP CANOPY
NFT

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SAVE 31%

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DIY

Auto SPRUCING UP YOUR INTERIOR

Carpet

BEFORE

The driver's footwell collects all sorts of foreign material that's best not thought about. Cleaning it, however, made a marked improvement in overall perception.



PRO: \$125 / DIY: \$25

AFTER

Liquid carpet cleaner and a stiff nylon brush loosened the dirt. I wiped up the excess liquid with a rag, then went at it with a shop vac. For a filthy carpet, repeat the process multiple times, then leave the car in a warm spot to fully dry. A rented steam vacuum can be useful to soak up the released grime. Don't forget to wipe the pedals.

Center Console



PRO: \$100

DIY: \$35

BEFORE

This rat's nest of wires once terminated in an acoustic equalizer. Remember when those were popular? There was also a dangling toggle switch that I learned operated the power antenna. The lower cubby was soaked with a dried, sticky mystery liquid.

AFTER

A \$5 piece of 1/8-inch-thick plastic made a handy switch panel. I secured it to an old radio chassis with sheet-metal screws. Down below, scrubbing and painting didn't improve the cubby. But a glued-in piece of drawer liner did.

BONUS BUDGET DIY TIPS



TIP 4

Get cozy with junkyards

Before we dig into any used-car project, we always visit the local salvage yards to see what's available. And don't forget Craigslist—that's where we found the window switches.

TIP 5

Hide that cracked dash

Besides sourcing a replacement (see tip 4), there aren't many options to fix a sun-cracked dash. Our favorite work-around: imitation suede fabric cut to fit and secured to the dash top with Velcro.

TIP 6

Craft free floor mats

Carpet remnants make terrific mats. Trim to fit, making sure the mat doesn't touch the pedals. It's also a good idea to zip-tie the carpet to the seat frame.

Car Clinic

by Ben Wojdyla

The Oil Circuit

UNSEEN AND UNSEXY, IT IS THE VASCULAR SYSTEM OF THE ENGINE. POOR PERFORMANCE HERE WILL GRIND THE ENGINE TO A HALT.

CAMSHAFT & HYDRAULIC LIFTERS

Camshafts operate the valves at high speeds and need plenty of oil; hydraulic lifters can't work without it.

CRANKSHAFT BEARINGS

The spine of the engine. If something goes wrong, it's paralyzed.

OIL FILTER

Dirty oil is almost as bad as no oil. The filter keeps it clean.

OIL-PRESSURE SENSOR

Taps into the oil circuit, usually on the side of the block.

OIL GALLERY

The pressurized passage that delivers oil to where it's needed.

OIL PUMP

Pulls oil from the pan and delivers it to all of the engine's vitals.

Oil Crisis

The oil light on my 2000 Chevy Cavalier comes on at low rpm and then shuts off as I start driving. I checked the oil level and it's fine. Is this something I should be worried about?

A Any time the oil light goes on, it's cause for concern. Many newer and high-feature cars have oil-life monitors that determine when the oil needs to be changed, but the glowing red oil light in your Cavalier indicates the oil pressure is low. That's bad for several reasons. Low pressure means there either isn't enough oil in the system or the oil pump isn't circulating enough oil to keep the critical bearing and friction surfaces lubricated. If the light comes on while at speed, do your best to pull off the road quickly, turn the engine off, and investigate the problem to avoid damage.

Oil is the lifeblood of any engine, but the oil circuit is probably the least appreciated engine system. The oil-supply path starts in the oil pan, where a pump sucks up the lubricating fluid and distributes it to passages cast into the block. From there oil is directed to the crankshaft bearings, the camshaft bearings, the valve shafts, and

DIY

Auto CAR CLINIC Q+A

other important moving parts. Modern oil formulations include detergents, so regular oil and filter changes at intervals recommended in the owner's manual generally keep the system happy. Unfortunately, everything wears over time, which increases the tiny gaps between sliding parts. Those alone can cause a slight drop in oil pressure, as can an aging pump.

Before you go too far in diagnosing the problem, it probably makes sense to double-check the oil level and top it off to make sure that isn't the problem. Since the light comes on at low engine speeds and then shuts off, the oil pump is probably fine; if the pump were dying, you'd see low pressure at high engine speeds as well. The most likely culprit is the sensor that operates the light. The sensor is screwed into the engine and has a probe that resides in an oil passage. It's basically an on/off switch that uses the oil pressure to close an electrical circuit. Sometimes a particle of dirt or some other foreign matter gets into the probe and fouls the part. The sensor is fairly easy to replace—as long as you can get at it, which is sometimes difficult. Unhook the wiring, loosen with a wrench, and follow the instructions to replace the sensor.

Take the car for a test drive and see if the light still goes on at idle. If it does, you might be due for a new oil pump after all.

Mystery Leak ➔ I just got new tires a few months ago, but since then one of them has been going flat regularly. I had that one checked out where I bought the tires, and there aren't any holes in it, so I'm perplexed. How does a tire with no leaks go flat?

This sounds like a riddle: How can a tire with no holes go flat? By not leaking through the tire, of course. Just because the tire itself is fine doesn't mean there aren't other avenues for air to escape. Two prominent possibilities are the valve stem and the wheel on which the tire is mounted. Usually, a new set of tires includes new valve stems, since they can go bad through use and from exposure to road chemicals. If a valve is bad you'll have a constant and very slow leak through the base or the valve body. The other possibility is that the mounting surface of the wheel where the bead of the tire seats has become damaged by corrosion or dented from hitting a pothole. To see where the problem is coming from, fully inflate the tire and dribble a mixture of dishwashing liquid and water onto the valve stem, around its base, and around the inside and outside edge of the wheel where the tire and rim meet. Any escaping air will produce bubbles in the soapy water at the site of the leak. Then you can take the tire to the shop where you purchased it (which is where this leak should have been diagnosed in the first place), knowing exactly what and where the problem is.

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Locked Out ➔ I have an older work truck, and although it still runs and drives great, I've noticed the key lock tumbler on the driver's side door is starting to get finicky. When I put the key in, I have to jiggle it around before the tumblers will turn in the lock. Is there a way to fix this without too much trouble?

Doors and door parts—especially on the driver's side—get a huge amount of use and abuse. The advent of keyless entry has reduced the number of cycles a lock tumbler will experience, but manual locks get the what-for every time you enter the vehicle. The first thing you might try is spraying some graphite lube into the keyhole—if the mechanism is just sticking, this could be an easy fix. If that doesn't do it, you'll need to replace the lock tumbler with a new one; this ranges from a very simple procedure in old trucks to a bit tricky in new and high-feature pickups. The inexpensive option is to take the inner doors apart and swap the driver's side lock for the invariably less worn passenger-side tumbler. In all likelihood these are interchangeable parts and the passenger-side tumbler has another 200,000 miles' worth of use in it because it has gone through fewer cycles. The more fancy-pants fix is to get a new lock mechanism from your dealer for the driver's side door, machined to match the original keys that came with the truck. Obviously, this is a bit more expensive than swapping old parts around. I found that dealer pricing ranges from \$100 to \$200 for the complete job. Considering how cheap I am, taking a few minutes to transfer those locks side to side is what I'd go for.



PopMech on the Tube

■ Starting May 1, watch and learn from Ben as he performs a variety of auto repairs on the *Saturday Mechanic* show, part of a new YouTube automotive channel hosted by our colleagues at *Car and Driver*. Skype questions to Ben and he'll answer them on-air.

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DIY

Auto CAR CLINIC Q+A

Headlights Don't Need No Stinking Washers ➔ I have a 2000 Audi A4, and the headlight washers don't work. My dealer says it'll cost \$350 to get them fixed. Is there a less expensive solution?

The short answer is no. Audi vehicles—and VW Group cars in general—aren't cheap to fix. I have a similar vintage A4 and my headlight squirters don't work either. It might be something simple and silly like a loose wire to the pump motor, so it's worth checking those connections. It could also be grime in the mechanism that lets the washers pop up out of the bumper. Could be clogged hoses, or a clogged filter at the bottom of the washer fluid bottle. But if it's not any of those problems, I've got another suggestion: Don't worry about it. At some point you have to draw the line between a convenience you want and a feature you need—powered headlight washers fall entirely within the “want” category. Let's be rational about it: If you factor the \$350 you'd spend to fix these washers into a cost-per-use ratio, I'd wager that you'd be spending quite a bit for every squirt of fluid to kind of clean the headlights. You're really better off just stopping at a gas station and using the squeegee to clean the lenses. This might be a rather unsatisfying answer, but sometimes frivolous features like these should be left to die.

Near Correction ➔ Your response to the “Boiling Point” question in the February 2012 Car Clinic is way out there. The question said that the car overheated, but turning on the a/c caused it to cool down. That's a classic problem. Turning on the a/c engaged the secondary cooling fan, which increased airflow. This means the main cooling fan wasn't working; the questioner should have checked the fuse and the wiring.

This is a case of too little space in the magazine. Whenever a reader asks a question, it usually comes with loads of details, which we edit to fit into the allotted pages. In the original version of this question, the reader specifically stated that the main cooling fans were working fine, so I focused on the other possibilities. In retrospect I should have noted the fans still worked and maybe mentioned that the thermostat switch that controls the fans should be inspected as well. In the future I'll make sure to include all the relevant details for every question. Thanks to all the many (many!) readers who sent letters correcting me on this—it's good to know you're paying close attention. **PM**

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Ask Ben about it. Send your questions to pmautoclinic@hearst.com or over Twitter at twitter.com/PopMechAuto or to Car Clinic, Popular Mechanics, 300 W. 57th St., New York, NY 10019-5899. While we cannot answer questions individually, problems of general interest will be discussed in the column.



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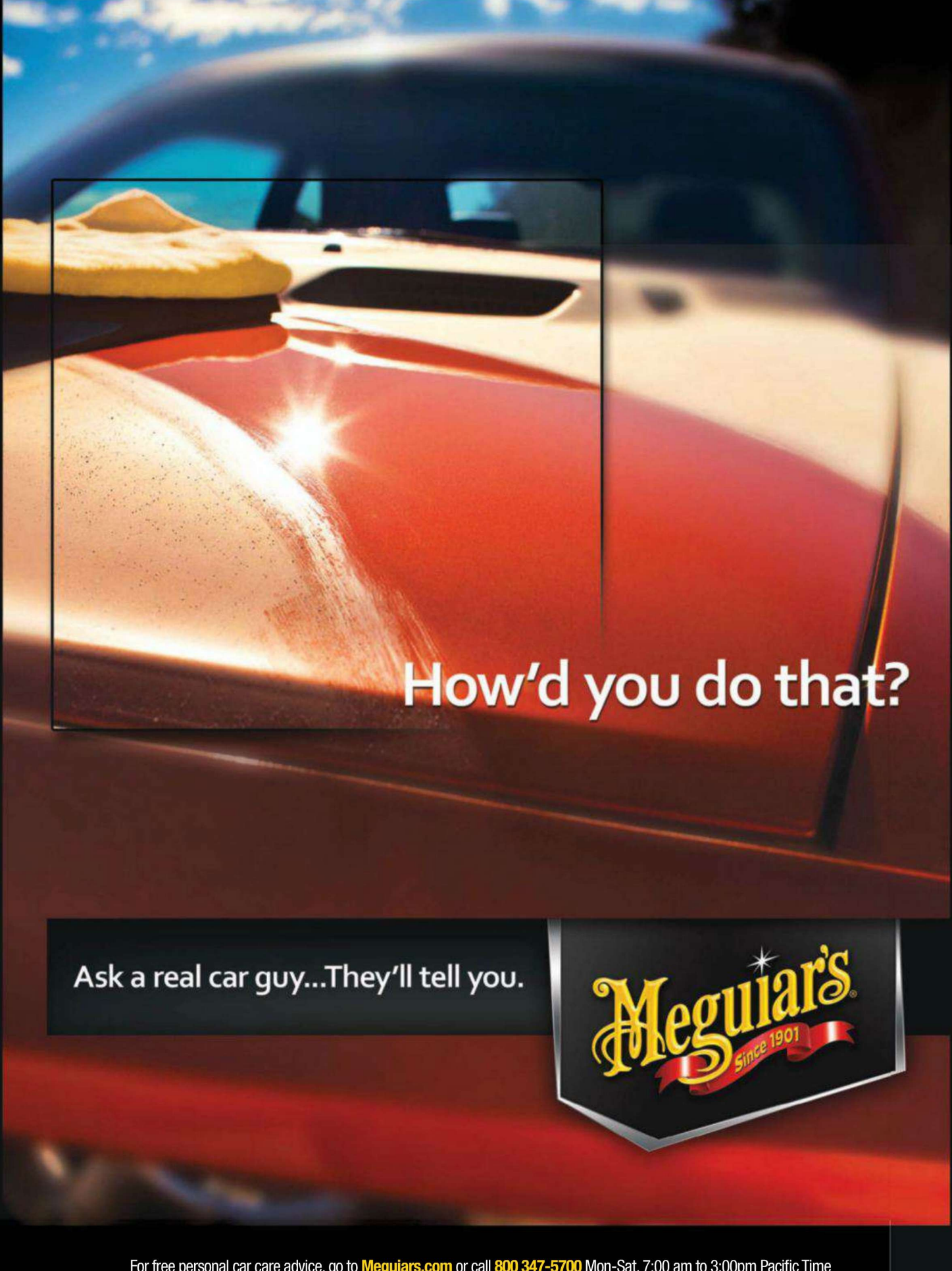
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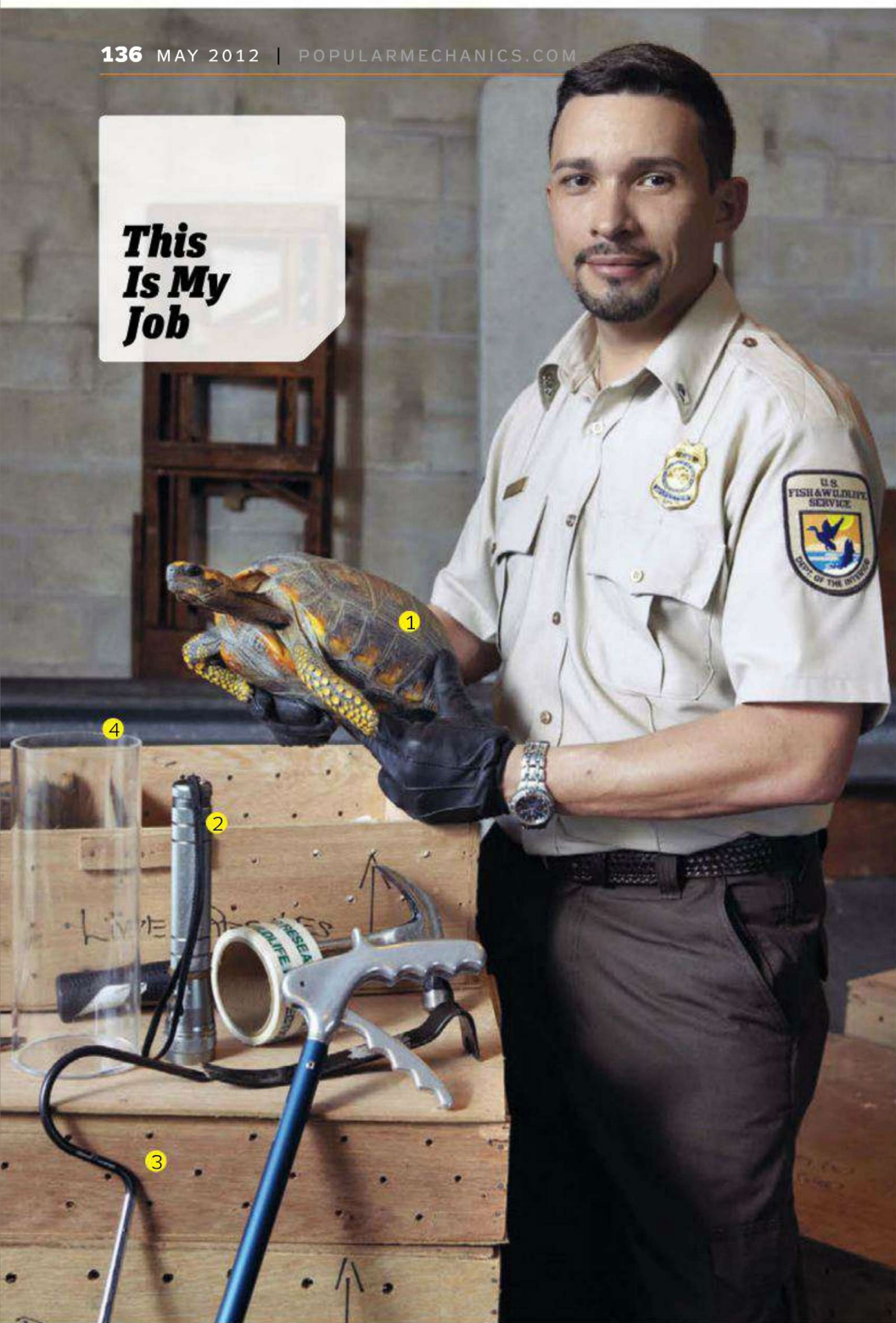
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1. LIVE ANIMALS

During PM's visit, González inspected shipments of green anacondas, Goliath bird-eater tarantulas, smooth-fronted caimans, and yellow-footed tortoises (left). "With the exception of the tarantula, all the animals are protected by CITES—the Convention on International Trade in Endangered Species," he says. "Not all the animals are endangered, but CITES regulates their trade to prevent them from going extinct." The biggest challenge is identification: "Species from the same genus can look alike except for one detail. One is protected, the other is not."

2. FLASHLIGHT

Wildlife is shipped in bags or containers placed in crates. González dons a pair of Kevlar-lined gloves, then shines a flashlight inside the box to check for loose animals—like the monitor lizards he recently found at large. "If we can handle the animal, then we'll try to catch it," he says. "If not, we close the box, contact the importer, and let them do it."

3. SNAKE HOOK

In 2011 more than 36.8 million animals were imported and exported through Miami, which receives more venomous animals than any other port in the U.S.—at least 16,000 last year—so snake hooks are essential. The inspectors relocate such shipments to a large room. "We don't want to be in a confined space in case the animals get loose," González says. "We want to have an open area where we can handle them with the hooks if necessary."

4. VIEWING TUBE

After a bag has been placed on the floor, inspectors insert a plexiglass viewing tube to see what's inside. Sometimes bags are mislabeled (by accident or on purpose), such as the one González peeked into that should have held frogs. The viewing tube showed its actual contents—scorpions—from a safe distance.

× **Alberto González has a checklist** 100 lines long of all the animals he'd like to see. As a wildlife inspector at the Port of Miami, he's already more than halfway through it: He has set eyes on everything from the world's most toxic snake, the taipan, to its biggest shark, the whale shark. The U.S. Fish and Wildlife Service hires inspectors to stop the illegal wildlife trade—at \$10 billion to \$20 billion per year, it's second only to arms and drug smuggling in the black market. "We have to understand and enforce a range of U.S. and international laws, regulations, and treaties that limit the commercial traffic of endangered wildlife. We must be able to identify thousands of different species. And we verify that live animals are transported humanely," González says. "Every day is a new challenge." — ERIN MCCARTHY



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